LAKE STATES FOREST EXPERIMENT STATION

SUBJECT MATTER INDEX

Technical Notes, Nos. 501 - 629

(End of series. Superseded by new series entitled "Research Notes.")

U.S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE

St. Paul 1, Minnesota

M. B. DICKERMAN, Director

1,363,477

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SUBJECT MATTER INDEX

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Forest Economics, and Timber Utilization and Marketing

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 501

32528

1956 Forest Tree Seed Crop Subnormal in the Lake States

During 1956 forest tree seed crops throughout the Lake States generally were poorer than in 1955 or than the average since 1950, according to observations made at field centers of the Lake States Forest Experiment Station. There were exceptions, of course, for some localities and some species. Red pine and white pine consistently had the poorest crops of any species observed extensively (see table on reverse side). Northern white-cedar had consistently the best crops. Among the hardwoods sugar maple generally had the best seed production. The oaks in general were poorest, although crop failures were reported in some localities for beech, yellow birch, paper birch, and quaking aspen. In general most conifers produced poor to failing crops in northern Minnesota and the Lower Peninsula of Michigan, poor to medium crops in northeastern Wisconsin, and medium to bumper crops in central Upper Michigan.

In northern Minnesota good crops were reported in some localities for white spruce, black spruce, northern white-cedar, and sugar maple. The following species had crop failures: Red pine, white pine, balsam fir, yellow birch, paper birch, and quaking aspen.

In northeastern Wisconsin northern white-cedar produced a bumper seed crop and tamarack, sugar maple, white ash, and black ash had good crops. Crop failures occurred among red pine, Scotch pine, and balsam fir.

Generally the best seed production took place in central Upper Michigan. White spruce and northern white-cedar produced bumper crops. Good crops were noted for black spruce, balsam fir, eastern hemlock, the maples, beech, paper birch, the aspens, and black ash. All other species had medium crops except red pine and white pine, which had crop failures.

Good to bumper crops of white spruce, balsam fir, and northern white-cedar were noted on Isle Royale.

In the Lower Peninsula of Michigan American elm was the only species with a good seed crop. Except for the maples with medium crops, all other species had poor to failing seed crops.

In north central North Dakota (reported for the first time) chokecherry had a bumper seed crop; boxelder, American elm, green ash, American plum, and Russian-olive had good crops; and hackberry, bur oak, and caragana had poor crops.

Because most seed collectors are interested chiefly in the pines, 1956 was a poor year in the Lake States. The spruces, of next greatest interest, presented a much more favorable picture, however, in Upper Michigan and in some parts of northern Minnesota. For those wildlife species depending largely on mast for winter food the poor oak and beech seed crops provide unfavorable conditions in northern Minnesota and Lower Michigan and only fair conditions in northeastern Wisconsin and Upper Michigan.

July 1957

PAUL O. RUDOLF, Forester

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--Forest tree seed crops in the Lake States, 1956.

Species	Estimated percentage of a full crop[1/] in--				
	Northern Minnesota	Northeastern Wisconsin	Central Upper Michigan	Lower Peninsula Michigan	North central North Dakota
Red pine	7	7	7	25	2/--
Eastern white pine	7	25	7	7	--
Jack pine	25-50	25	50	--	--
Scotch pine	--	7	--	--	--
White spruce	25-75	50	95	25	--
Black spruce	50-75	50	75	--	--
Norway spruce	--	25	--	--	--
Balsam fir	7	7	75	--	--
Eastern hemlock	--	25	75	--	--
Northern white-cedar	75	95	95	--	--
Tamarack	25	75	50	--	--
Sugar maple	75	75	75	50	--
Red maple	--	--	75	50	--
Boxelder	--	--	--	--	75
American beech	--	--	75	7	--
Basswood	--	25	50	--	--
Yellow birch	7	25	50	--	--
Paper birch	7-25	--	75	--	--
Quaking aspen	7	50	75	--	--
Bigtooth aspen	--	50	75	--	--
American elm	--	--	50	75	75
Hackberry	--	--	--	--	25
White ash	--	75	--	--	--
Black ash	--	75	75	--	--
Green ash	--	--	--	--	75
Bur oak	--	--	--	--	25
Northern pin oak	--	--	--	7	--
Black oak	--	--	--	7	--
Northern red oak	25	50	50	7	--
White oak	--	--	--	25	--
Chokecherry	--	--	--	--	95
American plum	--	--	--	--	75
Russian-olive	--	--	--	--	75
Caragana	--	--	--	--	25

1/ Percentages of a full crop are classified as follows: 0 - 15, failure; 16 - 35, poor; 36 - 60, fair; 61 - 90, good; 91 - 100, bumper.

2/ (--) signifies no report on this species.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 502

Aerial Spraying of Upland Brush Before Planting Effectively Reduces Need for Plantation Release

With most of the easy planting sites in the Lake States already in forest plantations, land managers are faced more and more frequently with the difficult problem of restoring conifers to land now occupied by brush or by broadleaf trees of poor quality. The most recent estimates indicate that there are about 7,650,000 acres of plantable commercial forest land in the region, and most of it falls in the brush category. Plantations put in on such land not only cost more initially than those on open land but also require considerable outlays later on to free the trees from brush competition. Both the cost of planting and the number of release jobs, however, can be reduced by special treatment of the site to kill back the brush the season before the area is planted.

Going over the site thoroughly with a heavy disk pulled by a 40- to 60-horsepower tractor in late June to early August has proven very effective, reducing the release job to 1 or 2 operations where otherwise 3 or 4 would be required. Disking, however, is slow work. Moreover, it costs $15 to $20 per acre and cannot be used on lowland or on rocky or steep upland sites.

In an attempt to speed up the preparation of extensive sites for planting and to lower the cost, foliage spraying with herbicides, applied at first with ground equipment and later from aircraft, has been used. This method, particularly aerial spraying, has proven an acceptable substitute for disking. Not only does it cost considerably less per acre but also it can be done far more rapidly and, equally important, with generally excellent results.

A typical example of aerial planting-site preparation is furnished by a 20-acre tract of brushy upland near Babbitt, Minn., on which it was planned to establish red pine and white spruce. This area had been logged for jack pine about 1945 and then planted to the same species, only to have the plantation destroyed by deer. At the time of spraying in late July 1954, the area was covered with a dense growth 4 to 6 feet tall of hazel, willow, green alder, mountain maple, and dogwood. The herbicide used was a 50-50 mixture of the low volatile esters of 2,4-D and 2,4,5-T applied at the rate of 2 pounds of acid in 4 gallons of oil-water emulsion per acre. In early May 1955, the entire tract and two strips in the adjoining unsprayed brush were planted to 1-2 red pine and 2-2 white spruce. Because of the excellent top kill, the planters were able to set trees in the middle of brush patches that otherwise could not have been planted.

(over)

EUGENE I. ROE, Forester
Lake States Forest Experiment Station
AUGUST E. BLOCK, District Ranger
Superior National Forest

July 1957

Naturally there has been some resprouting, but the new vegetation is not offering as much competition as was expected. An examination made by the Station and the Superior National Forest in October 1956 after 2 growing seasons shows that so few of the planted trees need release that this operation can be delayed for at least another year. Only 13 percent of the red pine and 25 percent of the white spruce are overtopped on the sprayed portion of the plantation, compared to 75 and 62 percent respectively on the unsprayed area. Furthermore, the white spruce averages almost 3 inches taller in the sprayed area.

Considering that the ground preparation job here cost only about $6 per acre and that the plantation can be brought through with no more than one subsequent release, it would appear that aerial spraying is fully as effective a method of site preparation as disking and much less costly. Considerable expansion in its use for preparing large areas of upland sites for planting therefore seems warranted.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 503

Early Thinning and Pruning Affect Limb-Free Length of Northern Hardwoods

Comparison of limb-free lengths of maple and elm crop trees 16 years after initial treatment has shown that the advantage resulting from early artificial pruning varies with species and thinning treatment.

A sapling stand of northern hardwoods was thinned in the spring of 1939 at age 11 years and again in 1947 to various radii (see table 1) around selected crop trees. The crop trees were pruned to one-half their height during each thinning operation. In 1939 the stand averaged 21 feet in height (average breast-height diameter was 2 inches); therefore, the crop trees were pruned from their original average limb-free length of 6 feet to an average of 10 feet on all treatments. The time required to prune to this height was 9 hours per acre or 1.6 minutes per crop tree. Pruning was rapid compared to coniferous species because of the low number of limbs removed--2.4 per tree pruned.

In 1947 at the time of the second thinning, the crop trees were pruned to heights of 14 to 15 feet.

Table 1 (on back of sheet) presents the data for a comparison of limb-free lengths of sugar maple and elm 16 years after the first thinning and pruning. Epicormic branches less than one-half inch in diameter were disragarded in the measurements.

Unpruned sugar maples in the unthinned plots have kept up with pruned trees in limb-free length. On thinned plots natural pruning has not been so rapid; pruned sugar maple averaged 2 to 3 feet more limb-free length than did unpruned trees.

American elm did not naturally prune itself as well as maple in the heavily stocked control plots. In fact, stand treatment had little effect on natural pruning. Pruned elm averaged 2 to 4 feet more limb-free length than unpruned trees regardless of stand density. This may be attributable to the branching habit of elm, that is, the early development of heavy limbs and forks.

In summary, artificial pruning of sugar maple in thinned stands to one-half tree height resulted in a longer limb-free bole than natural pruning. But on dense, unthinned plots, unpruned sugar maple had a clear bole as long as or longer than pruned trees. American elm's limb-free length resulting from artificial pruning was greater than the length resulting from natural pruning whether released or not.

July 1957

DAVID F. CONOVER, Forester

Table 1.--Limb-free length of crop trees in 1939 and 1954.[1/]

S U G A R   M A P L E

Thinning radii (feet) 1939	Thinning radii (feet) 1947	Treatment	Average clear length[2/] Before treatment 1939	Average clear length[2/] 1954	Trees in sample[2/]
			Feet	Feet	Number
Unthinned		Pruned	5.7	15.7	59
Do.		Unpruned	5.9	16.1	23
2½	5	Pruned	5.9	15.5	56
2½	5	Unpruned	5.5	11.9	39
5	7	Pruned	6.0	14.0	56
5	7	Unpruned	6.1	12.0	48

A M E R I C A N   E L M

Thinning radii (feet) 1939	Thinning radii (feet) 1947	Treatment	Average clear length Before treatment 1939	Average clear length 1954	Trees in sample
Unthinned		Pruned	5.8	16.5	26
Do.		Unpruned	5.9	12.3	51
2½	5	Pruned	6.1	15.4	39
2½	5	Unpruned	5.7	13.2	30
5	7	Pruned	6.1	14.6	37
5	7	Unpruned	6.3	12.1	36

1/ Includes 16 growing seasons.

2/ Sample was restricted to trees having a limb-free length of 4.0 to 8.0 feet in 1939. Each figure represents data for the species from one ½-acre plot. Elm and maple data were taken from the same plot.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 504

Living Sphagnum Found Most Favorable Seedbed for Swamp Black Spruce in Minnesota Study

Condition of the seedbed has been recognized as an important factor in the regeneration of swamp spruce for many years, but there are few data on this effect in Minnesota. After reproduction cutting, the seedbed pattern in spruce is a complex of mosses, litter, and small patches of bare peat and rotten wood. At the Big Falls Experimental Forest near Littlefork, Minn., a study of regeneration on clear-cut strips brought out the importance of living Sphagnum as compared to other seedbeds.

The experiment was established in a dense 85-year-old pure black spruce stand growing on 3 to 5 feet of peat. Before cutting, the groundcover was a mosaic of mosses. Several species of Sphagnum were common in depressions, and some formed hummocks. There were many patches of feather mosses (mostly species of *Calliergonella*, *Hylocomium*, and *Hypnum*) in level places and around the bases of trees. Species of *Dicranum* created small cushions.

Strips 1 chain wide were clear cut. Tests were also made of the effects of slash treatment.

Only 2 percent of the 180 permanent milacre quadrats were stocked with spruce seedlings immediately after logging. Within 3 seasons new seedlings brought stocking up to more than 66 percent, and there were over 2,900 seedlings per acre on all treatments. The decisive influence of seedbed type on the occurrence of seedlings is shown in table 1 (on back of sheet).

Moss seedbeds were the most important because they still covered more than 70 percent of the ground surface in all treatments 3 years after logging. Sphagnum, which covered 38 to 48 percent of the area, created the most favorable seedbed, accounting for 85 percent or more of the seedlings in all cases. The water retaining properties of Sphagnum are believed to be at least a partial explanation for the success of seedlings on these mosses. Establishment was poorer on dead Sphagnum than on the living mosses, but only a small proportion of the Sphagnum had died after cutting. On some sites Sphagnum outgrows spruce seedlings and completely engulfs them, but in this study area the desirable effects far outweighed this disadvantage.

Feather moss and *Dicranum* seedbeds were very unfavorable. Most of the species in these groups seem to grow best in heavy shade. They died out and dried up badly after logging, producing a critically dry seedbed during periods without rain. Even living feather mosses and *Dicranum* became very dry in normal summer droughts. Raw litter (mostly needles and twigs from slash piles) was an extremely poor seedbed also. The small amount of burned duff appears to have been as good a seedbed as Sphagnum. Miscellaneous seedbeds such as rotten wood and bare peat were sometimes favorable and sometimes poor, but they occupied too small an area to be of much practical importance.

(over)

July 1957

M. L. HEINSELMAN, Research Forester

Table 1.--Distribution of seedbed area and of black spruce seedlings on clear-cut strips by seedbed types and slash treatment, 3 seasons after logging.

Seedbed type	Slash left: Percent of- Total area	Total seedlings	Slash removed: Percent of- Total area	Total seedlings	Slash burned: Percent of- Total area	Total seedlings	Weighted average: Percent of- Total area	Total seedlings
Living Sphagnum	44.3	98.0	39.3	93.3	33.7	81.6	39.1	91.0
Dead Sphagnum	3.2	1.2	4.0	2.1	4.7	3.4	4.0	2.2
Living feather mosses	6.2	0	11.4	.4	9.5	3.0	9.0	1.1
Dead feather mosses	5.8	0	22.5	0	17.6	0	15.3	0
Living Dicranum	6.8	.8	11.7	.7	9.5	1.8	9.3	1.1
Dead Dicranum	4.0	0	5.6	0	6.5	0	5.4	0
Burned duff	-	-	.3	2.5	4.7	8.0	1.7	3.5
Raw litter	28.5	0	3.2	0	10.5	0	14.1	0
Other1/	1.2	0	2.0	1.0	3.3	2.2	2.1	1.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total seedlings per acre (number)	2,933		5,400		4,333		-----	

1/ "Other" includes several less common mosses, plus bare peat and rotten wood.

Slash treatments were: (1) Slash burned in windrows, (2) slash completely removed from strips, and (3) slash left undisturbed in windrows. On the burned areas only a light patchy duff burn resulted because the windrows were loose and ice remained under them. Needles and fine twigs were consumed by the fire.

A major effect of both slash burning and slash removal was to reduce the area covered by the very unfavorable raw litter seedbeds. The area of raw litter seed bed was cut from 28.5 percent on the untreated plots to 10.5 percent on the burn plots, and to only 3.2 percent where slash was piled off the strips (table 1).

Manipulation of seedbeds through cutting practices and slash treatment offers a means of attacking the spruce regeneration problem. It also appears that one ca foresee seedbed problems to some extent before cutting by assessing the moss cov on areas where harvest cuts are planned.

TECHNICAL NOTES

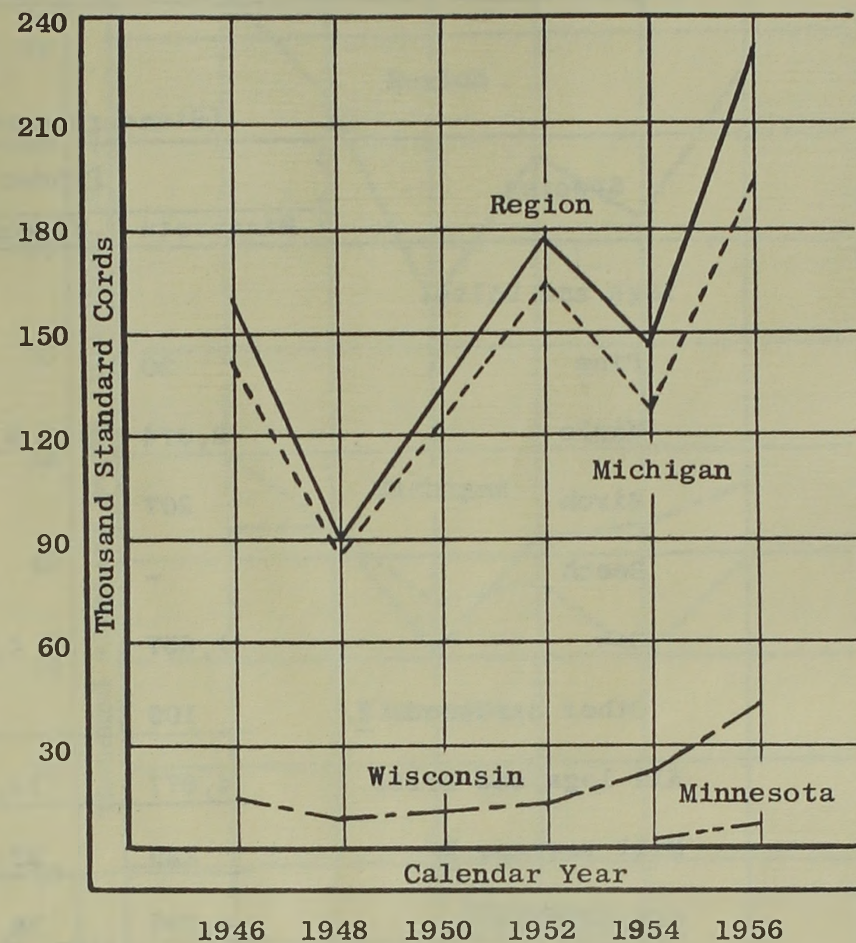
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 505

Production of chemical and charcoal wood increases in the Lake States, 1956

In addition to the two large chemical and charcoal plants operating in the Upper Peninsula of Michigan many small charcoal plants have been constructed and put into operation in the region during the past several years. According to a survey recently completed by the Station there are 15 plants in the area--6 in Wisconsin, 5 in Michigan, and 4 in Minnesota.

The local cut of chemical and charcoal wood for these plants amounted to approximately 236,000 cords in 1956 (see table reverse side). This production was approximately 61 percent above that of 1954. Of the regional total, Michigan produced about 82 percent, Wisconsin 16 percent, and Minnesota 2 percent.



Chemical and charcoal wood production
Lake States, 1946-56

In 1956 logs and bolts accounted for about 72 percent of the total wood used by the local industry; the remaining 28 percent was comprised of plant waste such as slabwood, edgings, and veneer cores. Maple, birch, beech, and oak were the principal species used.

October 1957

A. G. Horn
Forest Economist

Production of chemical wood and charcoal wood, Lake States, 1956

(Standard cords roughwood basis)

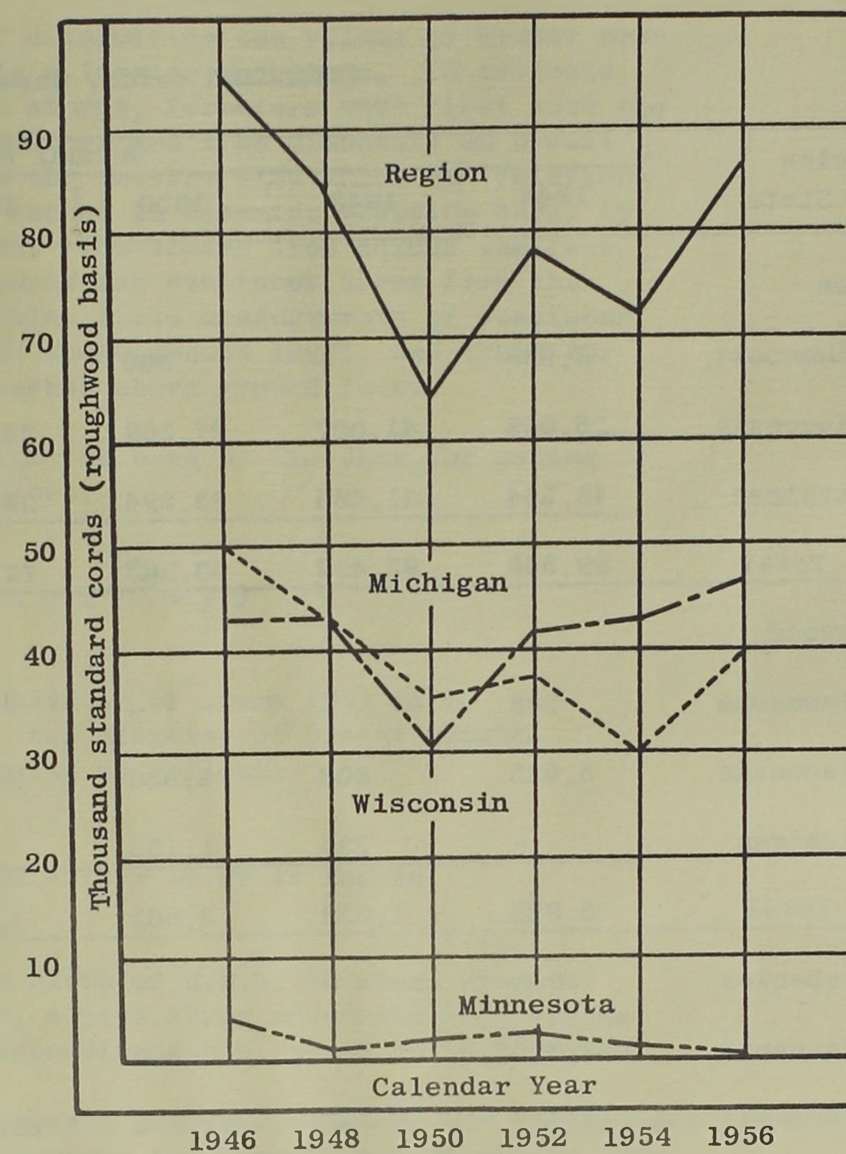
Species	Production by States			
	Minnesota	Wisconsin	Michigan	Region
Logs and bolts:				
Pine	30	-	-	30
Maple	2,674	9,235	79,933	91,842
Birch	207	697	45,297	46,201
Beech	-	-	20,084	20,084
Oak	1,557	4,792	40	6,389
Other hardwoods 1/	109	18	5,886	6,013
All logs and bolts	4,577	14,742	151,240	170,559
Mill residue 2/	129	23,806	41,781	65,716
All material	4,706	38,548	193,021	236,275

1/ Ash, elm, cherry.
2/ Slabwood, edgings, veneer cores, chips, etc.

TECHNICAL NOTES
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 506

Annual Cut of Excelsior Bolts Starts to Climb, Lake States

The 1956 cut of excelsior bolts in the Lake States amounted to approximately 86,000 cords. This is the second largest cut in recent years -- only 10 percent less than the high recorded in 1946 (see table reverse side).



Excelsior bolts produced in Lake States, 1946-1956

Except for 2 years, Wisconsin has been the largest producer of excelsior bolts in the region (see graph). In 1956 it accounted for about 55 percent of the total quantity produced; the remaining 45 percent was cut in Michigan. Since the closing of Minnesota's lone mill in 1946, production of excelsior bolts in that State has been limited to small amounts shipped to Wisconsin mills.

Aspen continued to be the principal excelsior species in the region. Basswood production dropped 54 percent below that of 1954.

OCTOBER 1957

A. G. HORN, Forest Economist

Annual cut of excelsior bolts by species and State, Lake States, 1946-1956

(Standard cords, unpeeled)

Species and State	Annual production						
	1946	1948	1950	1952	1954	1956	Average
Aspen							
Minnesota	2,988	-	300	596	700	-	764
Wisconsin	36,998	41,007	27,369	36,945	38,257	45,666	37,707
Michigan	49,554	41,485	33,294	38,249	28,873	38,828	38,381
Total	89,540	82,492	60,963	75,790	67,830	84,494	76,852
Basswood							
Minnesota	308	-	-	104	-	-	69
Wisconsin	5,615	803	2,556	3,710	3,392	1,681	2,960
Michigan	-	230	1,106	191	233	-	293
Total	5,923	1,033	3,662	4,005	3,625	1,681	3,322
All species							
Minnesota	3,296	-	300	700	700	-	833
Wisconsin	42,613	41,810	29,925	40,655	41,649	47,347	40,667
Michigan	49,554	41,715	34,400	38,440	29,106	38,828	38,674
Total	95,463	83,525	64,625	79,795	71,455	86,175	80,174

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 507

Tree Diameter at Breast Height in Relation to Stump Diameter by Species Group

A stump tally is one method of determining the volume of timber previously removed from an area in a logging operation. To estimate volume of standing timber from stumps, foresters must first know the relationship between stump diameters and tree diameters at breast height (d.b.h.). The table on the reverse side shows the relationships for stumps from 4 to 36 inches in diameter (outside bark) by softwoods, hardwoods, and aspen. The broken line across the face of the table separates the figures for sawtimber trees from the smaller timber. To use the table, field measurements of sawtimber stumps should be made 12 inches above ground level, and those for poletimber and saplings at 6 inches above ground level.

A simple rule-of-thumb that might be used by fieldmen for making stump to d.b.h. conversion follows:

$$D = Ds - \left(\frac{Ds}{10} + 1 \right)$$

For example: Where diameter of stump (Ds) is 20 inches, the diameter at breast height is computed as follows:

$$D = 20 - (2 + 1) \text{ or } 17 \text{ inches}$$

For more accurate readings the ratio of d.b.h. to stump diameter should be used. As an example, a pine stump measuring 28.4 inches has a ratio of .871; the corresponding d.b.h. would be 24.7 inches.

The data on which the table is based were collected by the field crews of the Office of Iron Range Resources and Rehabilitation during 1956 and 1957. Stump and d.b.h. measurements were made in a number of widely scattered timber stands selected at random for each major timber type. Nearly all of the softwood and aspen measurements were made in the northern district of Minnesota, while the hardwood study areas were limited largely to the central and southern sections of the State.

Arthur G. Horn, Forest Economist
Lake States Forest Expt. Station

Richard C. Keller, Collaborator
Office of Iron Range Resources
and Rehabilitation Commission

October 1957

(Over)

Diameter at breast height and stump diameter relationship 1/

Stump 2/ diameter (inches)	Diameter breast height			Ratio 3/		
	Softwoods	Hardwoods	Aspen	Softwoods	Hardwoods	Aspen
4.0	3	3	3	.725	.775	.775
5.0	4	4	4	.760	.800	.800
6.0	5	5	5	.783	.800	.800
7.0	6	6	6	.800	.814	.814
8.0	6	7	7	.812	.825	.816
9.0	7	7	7	.822	.830	.822
10.0	8	8	8	.830	.833	.824
11.0	9	9	9	.836	.836	.827
12.0	10	10	10	.842	.842	.833
13.0	11	11	11	.846	.844	.834
14.0	12	12	12	.850	.845	.836
15.0	13	13	13	.853	.847	.838
16.0	14	14	13	.856	.850	.838
17.0	15	14	14	.859	.853	.839
18.0	15	15	15	.861	.854	.839
19.0	16	16	16	.863	.854	.842
20.0	17	17	17	.864	.855	.842
21.0	18	18	18	.865	.855	.843
22.0	19	19	19	.866	.855	.843
23.0	20	20	19	.866	.857	.843
24.0	21	21	20	.867	.858	.844
25.0	22	21	21	.868	.858	.844
26.0	23	22		.869	.858	
27.0	23	23		.870	.858	
28.0	24	24		.871	.859	
29.0	25	25		.872	.859	
30.0	26	26		.873	.860	
31.0	27	27		.874	.860	
32.0	28	28		.875	.860	
33.0	29	28		.876	.861	
34.0	30	29		.876	.861	
35.0	31	30		.877	.861	
36.0	32	31		.878	.861	
Basis: No. of trees	1,440	841	412	1,440	841	412

1/ Data were collected in 1956 and 1957 in Minnesota.
2/ Stump diameters were measured at 12 inches above ground level for sawtimber and 6 inches above ground level for smaller trees.
3/ D.b.h. as a percent of stump diameter. Based on stump and d.b.h. measurements to the nearest tenth inch (all measurements outside bark).
Note: Broken line separates sawtimber size from poletimber and sapling sizes.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 508

Weather Station Records Not an Accurate Guide to Temperatures Lethal to the Shoot Moth

That overwintering larvae of the European pine shoot moth (Rhyacionia buoliana (Schiff.)) are unable to withstand temperatures below -18° F. has been proved fairly conclusively. Yet in the past few years this insect has become a serious problem in plantations located between Cadillac and Lake Michigan, although temperatures below -18° were reported in 1952, 1953, and 1954 at the official weather station at Cadillac, Mich.

In 1952-53 experiments were conducted to investigate the possibility of cold hardiness of the larvae in the Cadillac area. The laboratory results proved that -18° is a true minimum threshold and that the Cadillac population did not exhibit any cold hardiness.

The infested plantations are located approximately 20 miles west of Cadillac and 20 miles east of Lake Michigan. On the supposition that the actual minimum temperatures within the plantations are higher than those recorded at Cadillac, the minimum monthly temperatures and the average minimum daily temperatures for a 5-year period for Manistee (on Lake Michigan) and Cadillac were plotted to determine the tempering influence of Lake Michigan (figure 1 on back of sheet). Analysis of the data shows that the monthly minimum at Cadillac averaged 15.5° (±5.9°) lower than that recorded at Manistee. Also the average daily minimum at Cadillac was 6.5° (±2.4°) lower than at Manistee. The greatest difference occurred from December through April, the most important period in causing mortality of overwintering shoot moth larvae.

The minimum monthly temperature for January through March at Cadillac averaged below -10°; the minimum monthly temperature for Manistee does not normally go below 0° for the same period. Based on the plotted data, the temperature curve within the plantation area could be represented empirically by points located approximately midway between the Cadillac and Manistee curves. This would mean that a low of about -5° could be expected in the plantation area--well above the lethal -18° threshold. This was substantiated by limited field observations during 1954-56. Minimum temperature thermometers placed at various heights and points within infested plantations recorded lows of -6° and -5° in 1955 and 1956 respectively. Pre- and post-winter larval collections were made during this 3-year period to determine the degree of mortality. No significant over-wintering mortality occurred.

It therefore seems doubtful if spread of the European pine shoot moth in the study area will be limited by low winter temperatures. Temperatures rarely reach the low threshold for larval mortality, and they probably are further moderated by the surrounding trees and snow accumulation.

October 1957

L. C. BECKWITH, Entomologist

(Over)

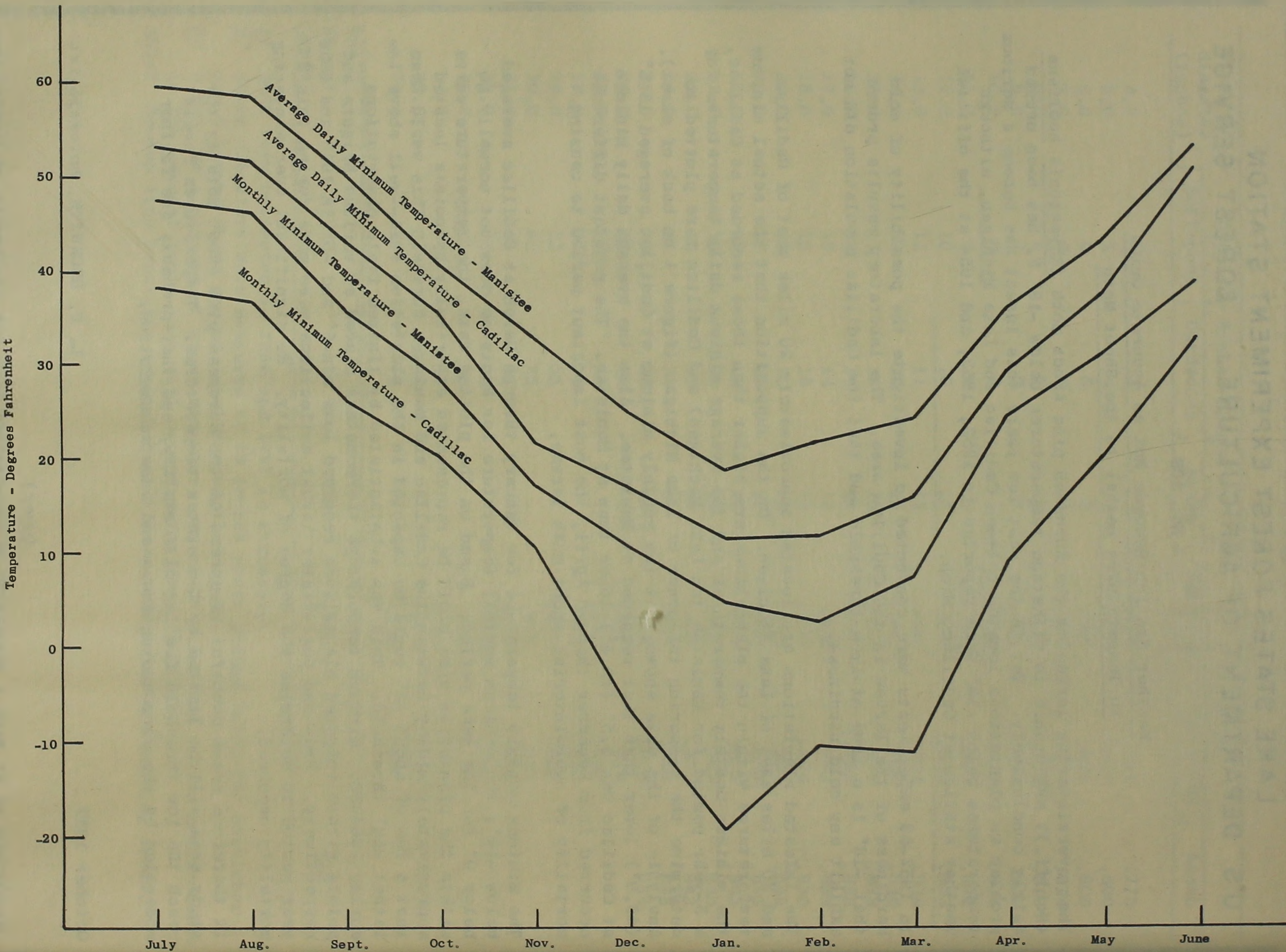


Fig. 1.--Five-year temperature records at Cadillac and Manistee, Mich.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 509

Dominant and Codominant Sugar Maple Trees Should be Favored in Thinning Young Stands

Few intermediate sugar maple trees have responded to thinning and improved their crown position class 16 years after treatment of a sapling stand in northern Wisconsin. This confirms earlier observations made on the same study.[1/]

In 1939 an 11-year-old northern hardwood stand (mostly sugar maple, American elm, white ash, and basswood) averaging 2 inches in diameter and 21 feet in height was thinned by the crop tree selection method. Before thinning, average stocking of trees 1 inch d.b.h. and up was 2,810 trees per acre. On each of twelve ½-acre plots, 150 to 200 potential crop trees (about half of them sugar maple) were selected and measured and their crown positions classified. All crown classes were sampled, although most trees were codominants or intermediates. Despite the risk involved in favoring intermediates, many of them were chosen for their excellent stem form and longer clear length plus the possibility that they could be helped through release. On four plots all trees within a 2½-foot radius of crop trees were removed while four other plots were thinned to a 5-foot radius; wolfish remnants of past logging were axe girdled. In 1947 the thinning radii were extended to 5 feet and 7 feet respectively. Four plots have been kept unthinned.

In 1954 an appraisal of the selected trees (see graph on back of sheet) showed that, while the relative position of dominants was little affected by treatment, many 1939 codominants and intermediates had regressed in their relative position in the canopy. This varied by treatment. For instance, the percentage of 1939 codominants suppressed and dead by 1954 was twice as great on the unthinned as on the more heavily thinned plots.

Thinnings increased slightly the number of intermediate trees that moved up into the dominant and codominant classes and generally reduced mortality and suppression. However, even on the more heavily thinned plots, 45 percent of the sugar maple intermediates were suppressed or dead by 1954. Some had been overtopped by the faster growing white ash and elm. This was mostly undesirable in elm, many of which were forked below 25 feet. Of the five suppressed trees chosen as crop trees (all on a lightly thinned plot) four were still suppressed and one dead in 1954.

The poor showing made by suppressed and intermediate sugar maples might have been improved by heavier thinning. However, many trees in these lower crown classes, because of their poor development prior to thinning, and perhaps inherently slow growth rate, did not have a high growth potential regardless of treatment. If thinnings in sapling hardwood stands are advisable and become economically feasible, dominant and codominant sugar maple should be favored for crop trees despite the apparent potential quality of some intermediate trees.

1/ Stoeckeler, Joseph H., and Arbogast, Carl F. Thinning and pruning in young second-growth hardwoods in northeastern Wisconsin. Soc. Amer. Foresters Proc. 1947: 328-346, illus. 1947.

October 1957

DAVID F. CONOVER, Forester

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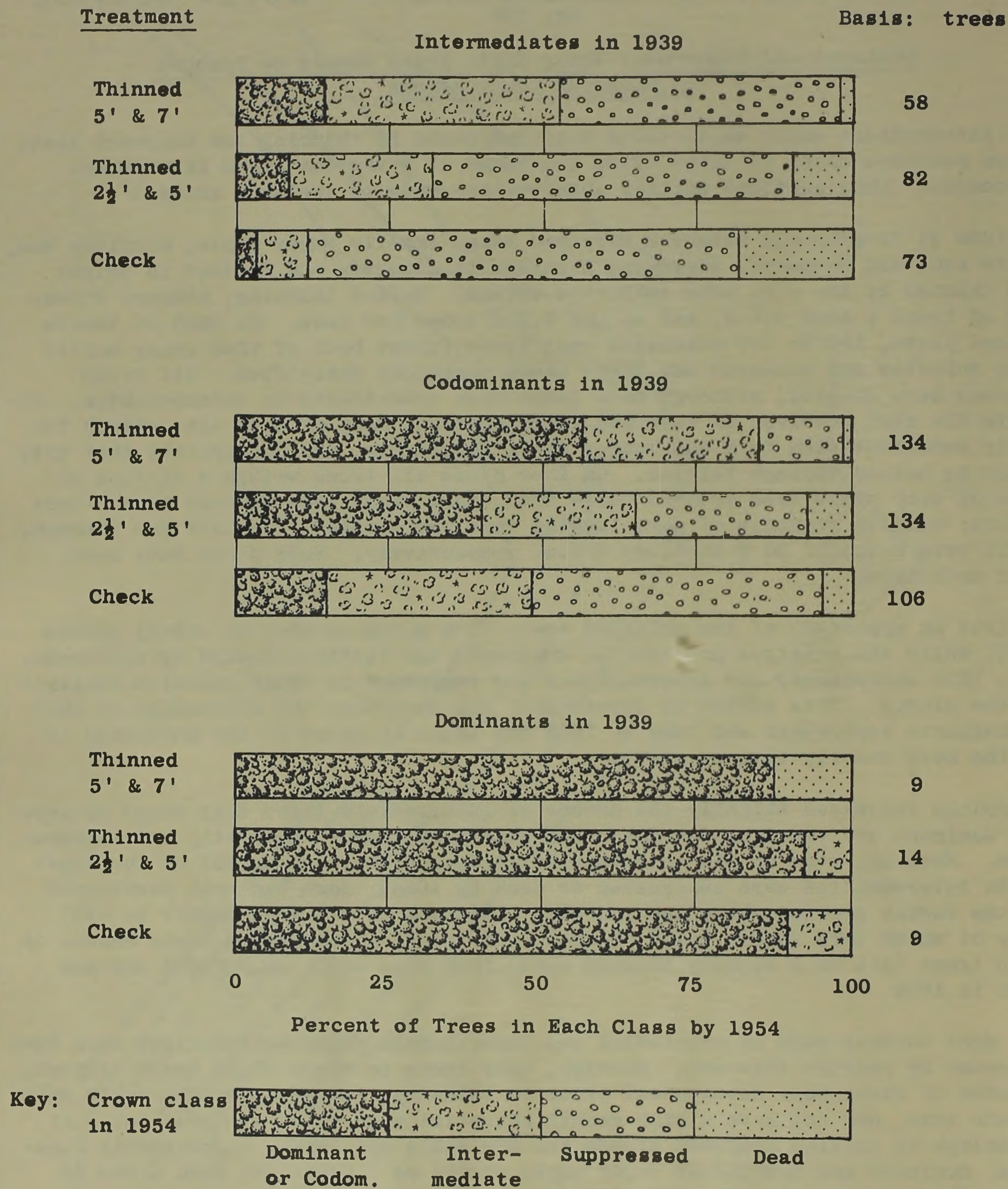


Figure 1.--1954 crown class of sugar maples selected as crop trees in 1939. Stand was thinned in 1939 and again in 1947.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 510

Is the Epicormic Branching Associated with Hardwood Pruning Wounds Influenced by Tree Crown Class?

A recent study of artificially pruned northern hardwoods revealed that trees in the dominant and codominant crown classes can be pruned without danger of epicormic branches developing around the pruning wounds. Pruning of trees in the lower crown classes, however, may result in considerable epicormic branching. Nineteen growing seasons after pruning, 78 percent of the sugar maple in the intermediate and suppressed crown classes had live epicormic branches around one or more pruning wounds. Indications are that epicormic branching of trees in the lower crown classes is also serious for other northern hardwood species; however, the limited sample of these species allows no definite conclusions to be drawn at this time. Two degrees of thinning produced no significant influence on epicormic branching.

These conclusions are based on the results of a study established in 1938 in northeastern Wisconsin. At that time, selected crop trees in an 11-year-old stand of northern hardwoods were pruned to one-half their total height and thinned to several degrees of stand density. The major components of this stand were sugar maple, American elm, American basswood, and white ash. Approximately 175 trees of all species were pruned per acre.

At the time of pruning, the stand had 2,810 trees per acre 0.6 inch and over in diameter; dominants averaged 2.0 inches in diameter and 21 feet in height. Detailed records were maintained on the development of epicormic branches associated with pruning wounds on 118 trees. Subsequent mortality reduced this number to 93 trees.

The effect of crown class of the pruned trees after 19 growing seasons on the incidence of epicormic branches is shown in table 1 (back of sheet). Of the 15 pruned trees that were suppressed in 1956, 13 (87 percent) have live epicormic branches around one or more pruning wounds. Of the 39 trees in the dominant class only 1 (3 percent) has epicormic branches.

In addition, the pruned trees also received the following degrees of thinning:

1. Heavy thinning.--Removed all competing trees within a 5-foot radius in 1938 and within 7 feet in 1947.

2. Light thinning.--Removed all competing trees within a 2.5-foot radius in 1938 and within 5 feet in 1947.

3. No thinning.

The effect of this thinning on the amount of live epicormic branches present in 1956 was very minor. Although there were slightly more epicormic branches per pruning wound on the unthinned area than on the thinned area, this difference was too small to indicate any practical significance.

October 1957

DARROLL D. SKILLING, Research Forester

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--The development of epicormic branches following artificial pruning of northern hardwoods, 1938-1956.

Species	1956 crown class1/	Trees pruned	Trees with epicormic branches2/	Pruning wounds	Wounds with epicormic branches	Total epicormic branches	Wounds with epicormic branches
		Number	Number	Number	Number	Number	Percent
Sugar maple	Dom.	6	1	10	1	1	10
	Codom.	14	1	38	1	1	3
	Int.	6	2	19	4	12	21
	Supp.	12	12	28	15	55	54
American elm	Dom.	14	0	36	0	0	0
	Codom.	3	0	4	0	0	0
	Int.	-	-	-	-	-	-
	Supp.	1	1	3	1	5	33
White ash	Dom.	11	0	39	0	0	0
	Codom.	2	0	4	0	0	0
	Int.	3	0	9	0	0	0
	Supp.	-	-	-	-	-	-
American basswood	Dom.	8	0	15	0	0	0
	Codom.	6	0	12	0	0	0
	Int.	5	0	9	0	0	0
	Supp.	2	0	6	0	0	0

1/ Abbreviations are for dominant, codominant, intermediate, and suppressed trees.

2/ Only live epicormic branches present in 1956 are considered.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 511

Disking Increases the Number and Growth of Yellow Birch Seedlings

Large quantities of yellow birch seed are produced nearly every year, but undisturbed forest litter, characteristic of winter-logged stands, acts as a physical barrier to yellow birch regeneration. Moisture is often inadequate for germination on this type of surface, and the seedling roots that do develop often dry out before they can penetrate the leaf layers to a suitable rooting medium. Severe shrub and grass competition also commonly occurs after heavy cutting on these sites, contributing to the high seedling mortality. Mechanical scarification of the seedbed promises to overcome these conditions and to encourage good establishment and growth of yellow birch seedlings, according to a study made on the Upper Peninsula Experimental Forest in Michigan.

In September 1953, one growing season after a heavy cut on a 20-acre tract of hemlock-yellow birch, one-half of the area was partially disked with an Athens-type disk-plow. Two hundred circular ¼-milacre quadrats were established immediately after disking in the scarified portion and remeasured each September to determine the annual change in number of yellow birch seedlings and the presence of associated species. Five intensities of disking were used to classify the quadrats: none, 25-, 50-, 75-, and 100-percent coverage. The actual amount of mineral soil exposed was slightly lower, varying with the type and firmness of the seedbed and the amount of established reproduction.

The highest number of yellow birch after treatment and at the end of 3 growing seasons occurred on the quadrats with 75 percent of their area disked (table 1). Complete disking resulted in fewer seedlings per acre but considerably more than on quadrats with 50-percent coverage. The quadrats with 25-percent disking and those undisked have fewer yellow birch seedlings now than they had immediately after treatment. Although survival has been low, the amount of yellow birch reproduction is still correlated with the intensity of scarification.

Table 1.--Annual changes in stocking and number of yellow birch seedlings per acre by degree of disking

Percent disked	Percent of quadrats stocked				Thousands of seedlings per acre			
	1953	1954	1955	1956	1953	1954	1955	1956
0	60.8	74.4	52.0	40.8	25.4	31.3	29.5	16.1
25	47.1	94.1	64.7	52.9	12.8	158.8	64.5	11.7
50	52.4	100.0	85.7	61.9	9.9	214.2	141.3	73.6
75	76.9	100.0	100.0	76.9	10.9	378.1	277.9	152.0
100	41.7	95.8	91.7	66.7	10.6	242.6	247.6	121.2

October 1957

R. M. GODMAN, Forester

(over)

In addition to increasing the germination by breaking up the thick leaf layers and exposing mineral soil, scarification eliminated or reduced the grass and shrub competition until the yellow birch was established and dominant over the competing vegetation. In heavily cut stands prompt yellow birch establishment is necessary, as grasses, sedges, and blackberries tend to invade the area completely within a 2- or 3-year period. Associated tree seedlings have offered little competition during the establishment period. Red maple has been the most aggressive, and is the only species other than yellow birch present on more than half of the quadrats. Sprouts, particularly those of red maple because of their rapid height growth and wide-spreading crowns, are beginning to compete with the yellow birch.

Height growth of the yellow birch seedlings was enhanced by disking, the 75-percent coverage resulting in the greatest increase into the 6- to 12-inch class during the second growing season after disking (table 2). This trend continued through the third growing season, but at a slightly lower rate. Growth into the 12- to 36-inch height class showed a sharp increase during the third growing season after treatment, the 75-percent coverage again showing the greatest increase.

Table 2.--Number of yellow birch seedlings in thousands per acre in the 6- to 12- and 12- to 36-inch height classes by degree of disking.

Percent disked	Seedlings 6 to 12 inches tall				Seedlings 12 to 36 inches tall			
	1953	1954	1955	1956	1953	1954	1955	1956
0	1.28	1.30	3.69	6.38	0.84	0.38	0.89	2.48
25	.65	2.06	14.04	5.81	.15	.32	.46	.96
50	.40	.52	21.83	35.40	.46	.14	1.54	12.85
75	.29	1.14	53.67	88.91	.00	.00	2.95	20.95
100	.75	.91	48.25	64.12	.00	.62	.75	12.88

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 512

Growth of Established Balsam Fir Reproduction Greatly Stimulated by Cutting

The forest floor of most balsam fir stands typically shows a large number of small seedlings of this species.[1/] In undisturbed stands, these seedlings hang on for a few years only to be shaded out and replaced by younger ones, which are also short lived.

This reproduction reserve is of great importance to the forester managing balsam fir lands, for by establishing the proper conditions for its vigorous growth he can, at will, stimulate replacements for harvested trees. A comparison of the reproduction now present on some experimental cuttings in balsam fir on the Chippewa National Forest with that following cutting in 1951 shows that the proportion of these small seedlings developing to more promising size depends closely on the degree of opening up of the stand (see table on back of sheet).

Although the total amount of reproduction has fallen off somewhat since cutting, it still remains at a high level. Of greater significance is the large number of seedlings that have grown into the 1-foot class and now have a reasonable chance of developing into trees.

Following logging, 1-foot seedlings averaged only 1,500 to 2,450 per acre on the cut plots and 3,000 on the uncut checks, or only 3 to 7 percent of all balsam fir reproduction. Now these larger seedlings range from 4,300 to 7,650 per acre on the three heavier cuttings (10 to 27 percent of all reproduction) compared to only 2,800 seedlings on the light cutting (8 percent) and 3,600 per acre on the check plots (5 percent). The gains average about 200 percent for the heavier cuttings but only 40 and 20 percent respectively for the remaining treatments.

The increase in the amount of the more promising reproduction is thus rather closely related to the amount of cover left. The greatest response occurred on the heaviest cutting and the smallest under no cutting. However, the moderate cutting shows almost as large an increase as the clear cutting and has the further advantage of promising frequent crops of balsam fir pulpwood. The lightest cutting, on the other hand, was definitely not heavy enough to stimulate growth of many seedlings.

Distribution of the larger seedlings has also improved considerably; 65 to 85 percent of the mil-acre quadrats are now stocked with seedlings 1 foot or more tall. Improvement in distribution, unlike that in the number of promising seedlings, seems to bear no relation to stand treatment.

Although the 2,800 and 3,600 one-foot seedlings per acre occurring on the light cutting and the uncut plots respectively would be enough reproduction under more open conditions, these seedlings are much less vigorous than those on the heavier cuttings, and considerable loss can be expected. On the more open cuttings, on the other hand, the seedlings are so thrifty that early thinning will be needed to prevent the areas from becoming overstocked.

1/ Eugene I. Roe. 1953. Regeneration of balsam fir guaranteed by continuous reserve of small seedlings. Lake States Forest Expt. Sta. Tech. Note 404, 1 p. (Processed.)

MAINTAINED AT ST. PAUL 1, MINNESOTA IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--Balsam fir reproduction following cutting in 1951 by cutting method

Treatment	Basal area left (sq. ft.)	Year	Balsam fir reproduction: Seedlings per acre: All	Seedlings per acre: 1 ft. or more tall	Percent of quadrats stocked with--: Any seedlings	Percent of quadrats stocked with--: Seedlings 1 ft. or more tall
Commercial clear cut	42	1951	35,800	2,450	95	65
		1956	28,850	7,650	90	85
Heavy selection	56	1951	46,600	1,500	95	55
		1956	41,300	4,300	95	70
Moderate selection	75	1951	48,800	1,550	95	50
		1956	28,950	4,750	100	65
Light selection	86	1951	38,950	2,000	100	50
		1956	35,500	2,800	100	75
Uncut	102	1951	83,350	3,000	100	55
		1956	67,350	3,600	100	70

October 1957

EUGENE I. ROE, Forester

TECHNICAL NOTES

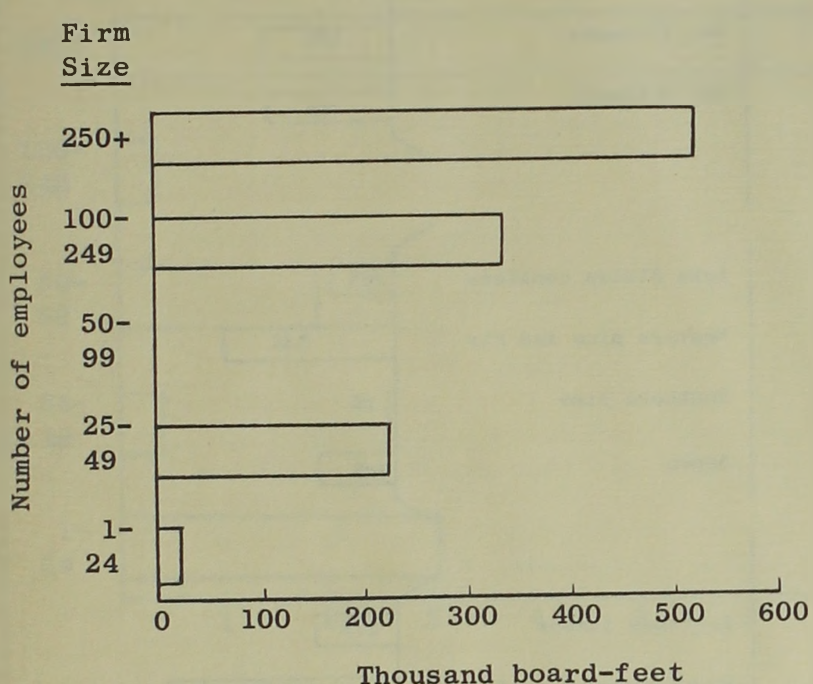
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 513

The Twin Cities Electrical Machinery Industries as Users of Wood

The electrical machinery industries as defined by the Standard Industrial Classification used by the Bureau of the Census comprise about 60 firms within the city limits of Minneapolis and St. Paul.1/ During 1956 one-half of these firms purchased lumber, primarily for use in product manufacture and crating, and to a lesser extent for pallets, skids, patterns, and general plant maintenance.

How much wood does this industry group purchase?--The firms in this industry group purchased an estimated 1,110,000 board-feet of lumber in 1956.2/ These purchases are presented graphically below by firm-size groupings.



Firm Size	Firms in sample	Known firms
250+	6	6
100-249	4	6
50-99	3	3
25-49	6	10
1-24	15	36

1/ These firms manufacture electrical appliances, generating and transmitting apparatus, the whole line of communication equipment, electric equipment for automobiles, and a number of miscellaneous electrical products. The listing of individual firms used in this study is based on the 1955 Minnesota Directory of Manufacturers, as tabulated and published by the Minnesota Department of Business Development. Data presented here were developed from interview contacts with sample industries by the Division of Forestry, Minnesota Conservation Department.

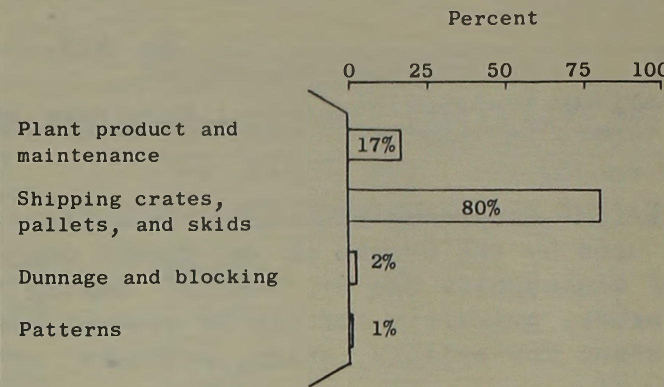
2/ The standard error is ± 16 percent--that is, the chances are 2 out of 3 that this estimate does not deviate from the true figure by more than 178,000 board-feet.

OCTOBER 1957

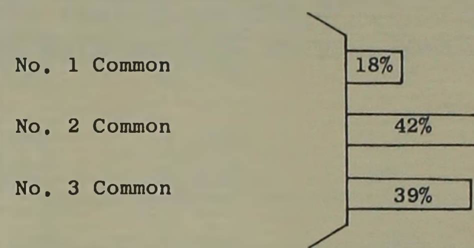
JOHN R. WARNER, Research Forester

(Over)

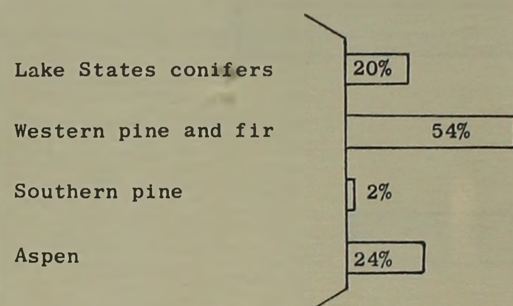
What is the wood used for?
All but two firms purchasing wood used part of it in crating. This use alone accounted for 79 percent of the total. On the other hand, plant maintenance used less than 1 percent of the total.



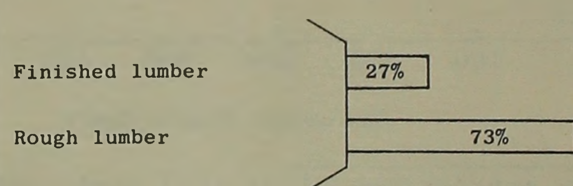
What quality of wood is used?
The three grades opposite include 99 percent of the lumber volume purchased and represent the softwood group plus aspen. Miscellaneous hardwoods comprised less than 1 percent, of which three-quarters was No. 3 Common and the remainder FAS.



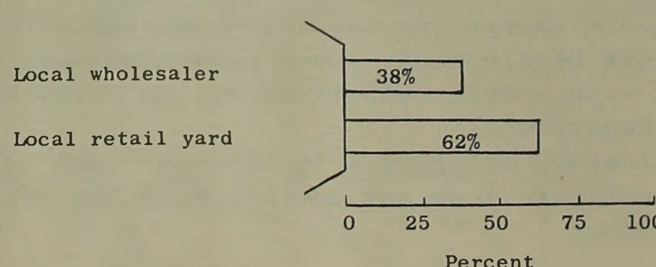
What species are used?
Forty-four percent of the volume was of Lake States species. Less than one-half of 1 percent of this was made up of the denser hardwood species.



In what form is it purchased?
All of the rough lumber and more than 60 percent of the finished lumber was purchased air-dry. No firm reported the purchase of green lumber.



Where is it obtained?
There were no direct purchases of lumber from western mills. Every sample firm contacted purchased its lumber, dimension, and blocking needs from local suppliers.



TECHNICAL NOTES

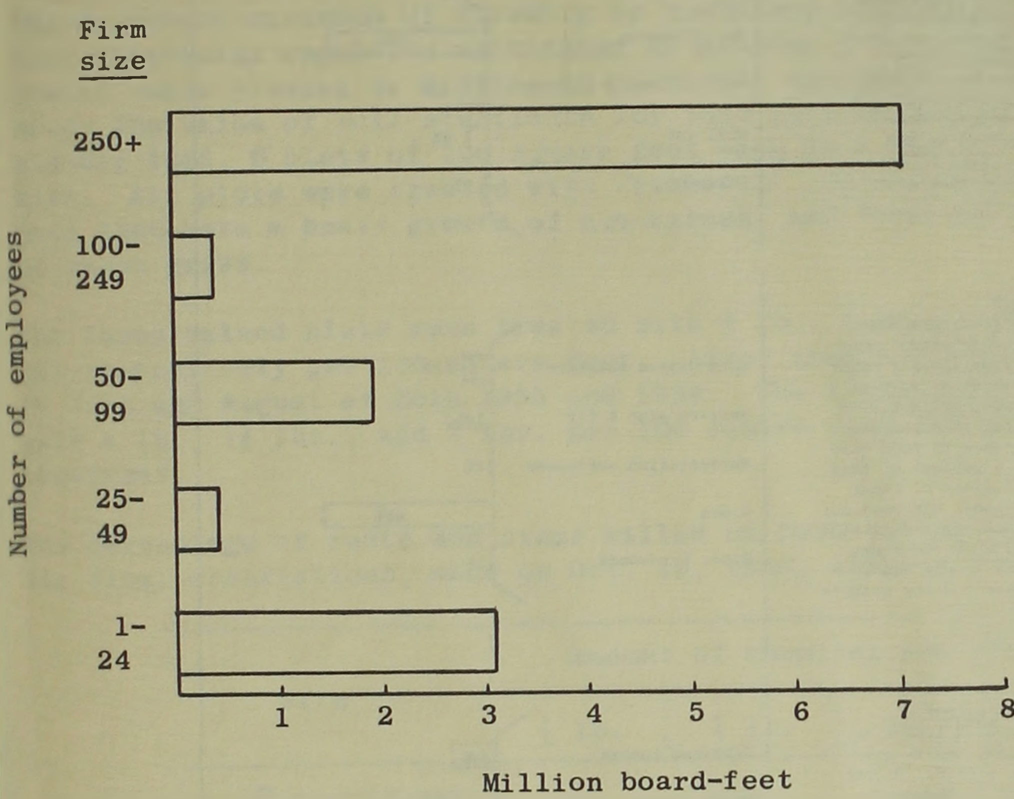
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 514

The Twin Cities Nonelectrical Machinery Industries as Users of Wood

About 260 industrial firms operating within the city limits of Minneapolis and St. Paul manufacture an extensive variety of nonelectrical machinery for industry, agriculture, and the home.[1/] During 1956 slightly more than one-half of these firms purchased lumber, dimension, or blocking for use in their business. Average use of this wood material per firm is in excess of 34,000 board-feet.

How much wood does this industry group purchase?--Estimated purchases by these firms of lumber, dimension, and blocking for 1956 total 12,760,000 board-feet.[2/] The origin of these purchases by firm-size groups is presented graphically below.



Firm size	Firms in sample	Known firms
250+	18	18
100-249	8	19
50-99	8	31
25-49	15	39
1-24	54	152

1/ For analysis purposes these firms have been placed in the manufacturing category of the Standard Industrial Classification as used by the Bureau of the Census. They include companies manufacturing engines; machinery used in agriculture, quarrying and mining, metalworking, offices and stores, service industries, and households; and a variety of special and general industrial machinery and machine parts. The listing of these firms was taken from the 1955 Minnesota Directory of Manufacturers, as tabulated and published by the Minnesota Department of Business Development. Data presented here were developed from interview contacts with sample industries by the Division of Forestry, Minnesota Conservation Department.

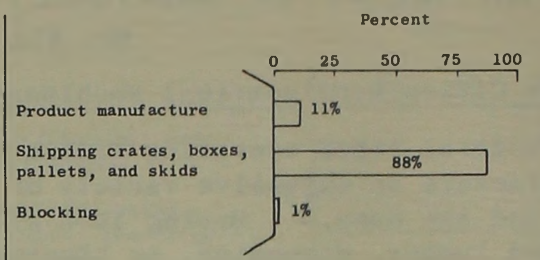
2/ The standard error is ± 16 percent--that is, the chances are 2 out of 3 that this estimate does not deviate from the true figure by more than 2,040,000 board-feet.

OCTOBER 1957

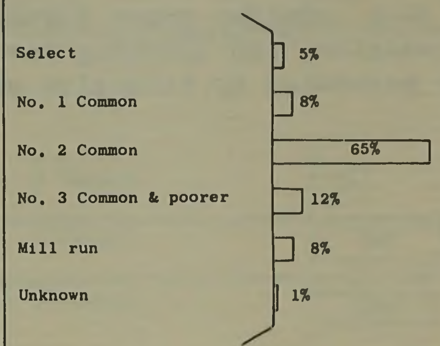
JOHN R. WARNER, Research Forester

(Over)

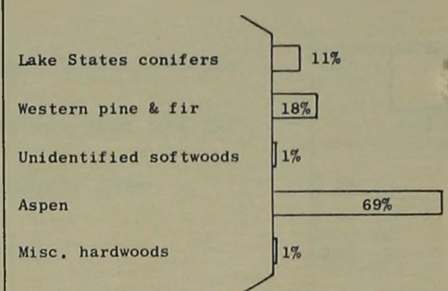
What is the wood used for?
Shipping uses overshadowed all others. Only 1 percent of the wood used in the shipping category was for crating and boxing goods for overseas delivery. Another 1 percent of this group was used in pallet and skid construction and repair. Manufacture of food freezers accounted for nearly 10 percent of wood use in the product category. The remainder went into a wide variety of other products.



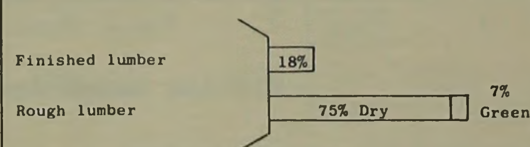
What quality of wood is used?
Within the softwood grades listed on the right, Select and No. 1 Common were used almost exclusively in product manufacture. The remaining grades were used predominantly in product shipment. Ninety-five percent of the No. 2 Common category was aspen and was used by a single firm for making boxes and crates for shipment of their product. Miscellaneous hardwoods made up the remaining 1 percent. Half of this was FAS and Select, the remainder No. 2 Common.



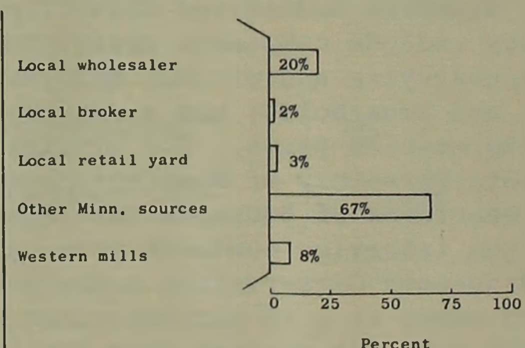
What species are used?
Aspen and Lake States conifers made up 80 percent of the wood used. Over half of the Western pine and fir category was used in fabricating walk-in food freezers. Diagonal grain fir is the favored species for this purpose because of its resistance to food odor absorption. Another 7 percent of this group was used in a variety of other products and the remainder was used for boxes, crating, and pallets. Oaks made up the greatest portion of the dense hardwood category with almost equal volumes used in crating and for pallets and skids.



In what form is it purchased?
Nearly all of the finished lumber was purchased as kiln-dried, the larger part being of Western origin. Of the rough dry lumber, only 12 thousand board-feet (only 0.1 of 1 percent) was kiln-dried. The remainder was air-dry.



Where is it obtained?
Sawmills, wholesalers, and brokers in northern Minnesota communities supplied 92 percent of the total, with direct shipments from western mills making up the balance.



TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 515

Sodium Borates Show Promise for Grass Control

A constantly increasing acreage of plantations in the Lake States makes the economical and effective maintenance of firebreaks more and more important. The use of chemicals in the control of herbaceous and grassy cover on firebreaks offers interesting possibilities to the agencies charged with protecting these plantings from fire.

The Minnesota Division of Forestry is concerned with the control of grass on upland firebreaks regularly maintained by plowing or disking, and on lowland firebreaks where plowing or disking is difficult except in extremely dry weather. To study the value of soil sterilants for this purpose the Division established, in mid-May 1955, 6 plots of 100 square feet each in a firebreak near Hill City, Minn. All plots were treated with Ureabor.[1/] Three of the plots were on loamy sand that bore a heavy growth of quackgrass, and three on peat with a heavy cover of marsh grass.

The three upland plots were treated with ½ lb., 1 lb., and 1½ lbs. of the chemical respectively per 100 square feet. After chemical treatment they were disked in June and August of both 1955 and 1956. The three lowland plots were treated with 1 lb., 1½ lbs., and 2 lbs. per 100 square feet but received no further treatment.

The percentage of roots and stems killed on both sites, shown below, is based on the final observations, made on Oct. 19, 1956, after 2 growing seasons.

Site	Amount of chemical per 100 sq. ft.:			
	½ lb.	1 lb.	1½ lbs.	2 lbs.
Upland (loamy sand)	50	75	100	
Lowland (peat)		50	80	90

Maximum kill on the upland plots occurred about 1 month after treatment, and remained about the same until the last observation. Most of the unkilled grass on the lowland plots was on hummocks extending 6 to 12 inches above normal ground level. Major results were apparent 3 weeks after treatment, but less green grass was found in 1956 than in 1955.

1/ Disodium tetraborate pentahydrate--63.2 percent; disodium tetraborate decahydrate--30.8 percent; 3(p-chlorophenyl)-1, 1-dimethylurea--4 percent.

Although the grass cover on the untreated firebreak adjacent to the upland plots was destroyed by each disking, it soon resprouted to a height of 6 to 12 inches.

These results indicate that Ureabor is worthy of further testing as an aid in firebreak maintenance. Future trials should be done on a scale large enough to allow for cost analysis and comparisons with other methods in overall effectiveness and economy.

GEORGE GAYLORD
Minnesota Division of Forestry
E. I. ROE
Lake States Forest Experiment Station

January 1958

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 516

Tests of Some Chemicals for Grass Control on Firebreaks

The Minnesota Division of Forestry began a series of tests in May 1955 to determine the value of several chemicals for the control of vegetation on established firebreaks. The results of the first experiment were reported in Technical Note No. 515. A second series of plots established in late May and early June 1956 tested additional chemical formulations. The chemicals used, rates of application, and the results are presented in table 1 (reverse of this sheet). Initial kill of grass was at a maximum by July 1. Regrowth was estimated on October 19 of the same season and again on October 29, 1957.

The chemicals were applied on 12x25-foot plots in 4 series: 2 on upland loamy sand and 2 on lowland peat. On each site a series of 10 plots was scarified by light bulldozing previous to chemical treatment. On the upland loamy sand the remaining 10 plots had no other treatment, but the unscarified plots on lowland peat were burned before applying the chemicals. (Because of standing water, burning removed only about 50 percent of the dead grass stems.)

Commercially mixed preparations (described in footnote 2, table 1) were used. The amounts shown in the table are the weights or volumes of the product applied in pounds or gallons per acre. All were mixed and applied with a liquid carrier at a rate of 72 gallons per acre, except the Ureabor, which was used in its dry form.

The fall 1956 examination showed grass on the control (untreated) plots averaging about 12 inches high on the upland site and 18 to 19 inches on the lowland peat. The regrowth was less than 3 inches tall on the treated upland plots and averaged between 2 and 4 inches on the lowland site.

By the end of the second season, however, the grass had made practically complete recovery in density (it still ran somewhat shorter on the lowland) on all plots except those treated with Ureabor. Upland plots treated with this sterilant were still mostly bare with only a few blades of grass showing. These averaged 2 inches in height compared to 10 inches on the other upland plots.

In summary, only Ureabor showed enough promise to merit further trials on a larger scale. Although several of the other chemicals showed excellent initial kill, the grass so treated made rapid recovery. These would therefore not be satisfactory for firebreak maintenance.

GEORGE GAYLORD
Minnesota Division of Forestry
E. I. ROE
Lake States Forest Experiment Station

January 1958

Table 1.--Initial kill and regrowth of grass by kind of treatment[1]
(in percent)

Chemical[2] and quantity per acre	Loamy sand						Peat					
	Not bulldozed			Bulldozed			Burned			Bulldozed		
	Initial kill	Regrowth 1956	Regrowth 1957	Initial kill	Regrowth 1956	Regrowth 1957	Initial kill	Regrowth 1956	Regrowth 1957	Initial kill	Regrowth 1956	Regrowth 1957
Ureabor (436 lbs.)	99	0	30	99	0	2	100	0	100	90	0	60
Ureabor (653 lbs.)	99	0	3	98	0	1	95	1	25	97	0	10
Radapon (40 lbs.) plus Esteron Ten-Ten (1.12 gals.)	100	50	100	90	5	100	100	0	80	75	2	95
Radapon (20 lbs.) plus Esteron Ten-Ten (0.56 gals.)	80	50	100	95	60	100	90	2	100	70	80	100
Radapon (40 lbs.) plus Esteron 245 (1.12 gals.)	95	20	100	95	40	100	90	1	90	40	40	100
Radapon (20 lbs.) plus Esteron 245 (0.56 gals.)	95	20	100	90	60	100	35	0	100	35	20	100
Baron (30 gals.)	99	1	35	95	5	75	70	1	65	60	2	75
Baron (15 gals.)	90	3	70	95	2	50	50	2	95	90	1	50
Telvar W (10 lbs.)	50	0	60	20	80	55	40	80	100	70	20	80
Telvar W (4.5 lbs.) plus Weedazol (9 lbs.)	20	90	100	20	80	65	35	80	95	40	10	100
Control (no chemical treatment)	0	-	100	50	-	65	0	-	100	25	-	100

1/ Plots were treated in late May or early June; initial kill was measured on July 1, 1956, and regrowth on October 19, 1956, and October 29, 1957.

2/ Chemicals used were:

Ureabor: Disodium tetraborate pentahydrate--63.2 percent; disodium tetraborate decahydrate--30.8 percent; 3(p-chlorophenyl)-1, 1-dimethylurea--4 percent
Radapon: Sodium 2, 2-dichloropropionate--82 percent
Esteron Ten Ten: Propylene glycol butyl ether ester of 2,4-dichlorophenoxyacetic acid--70.5 percent
Esteron 245: Propylene glycol butyl ether ester of 2,4,5-trichlorophenoxyacetic acid--65.3 percent
Baron: 2-(2,4,5-trichlorophenoxy) ethyl 2, 2-dichloropropionate--30.5 percent
Telvar W: 3-(p-chlorophenyl)-1, 1-dimethylurea--80 percent
Weedazol: (3-amino, 1,2,4-triazole)--50 percent

TECHNICAL NOTES

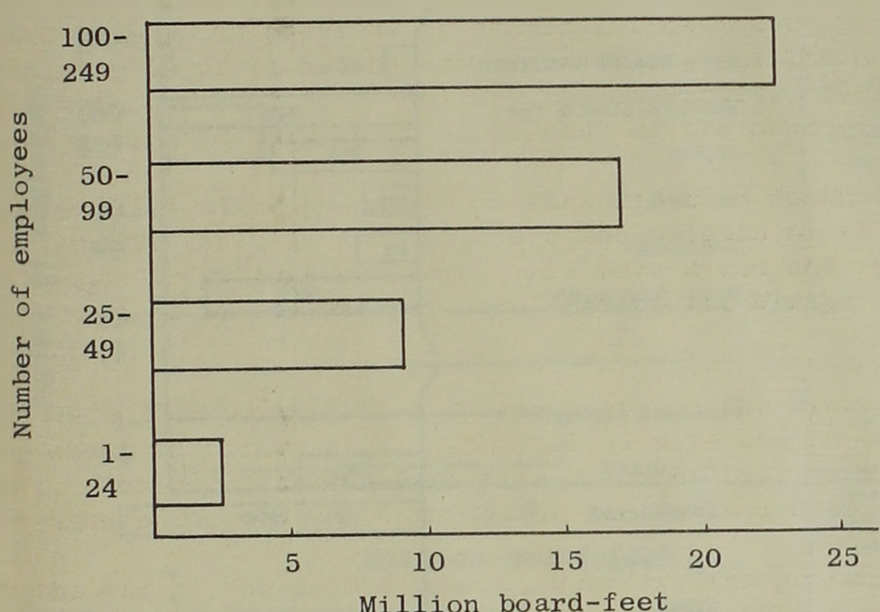
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 517

The Twin Cities Lumber and Wood Products Industries as Users of Wood

About 65 manufacturing industries in Minneapolis and St. Paul are included under the Standard Industrial Classification of Lumber and Wood Products.1/ At least 50 of these firms purchased lumber, including dimension and blocking, for manufacture of a wide variety of products during 1956.

How much wood do lumber and wood products industries use?--Lumber purchases for 1956 are estimated at 51,110,000 board-feet.2/ These purchases are shown graphically below by firm-size groups.



Firm size	Firms in sample	Known firms
100-249	4	8
50-99	4	7
25-49	5	12
1-24	18	38

1/ These firms are active in four general areas of manufacture: Sawmilling and planing, millwork and prefabricated wood products, wooden boxes and containers, and a loose category of miscellaneous wood products. Data presented here are based on a sample taken from the 1955 Minnesota Directory of Manufacturers as tabulated and published by the Minnesota Department of Business Development. Interviews with the sample firms were made by private forest management Service Foresters of the Division of Forestry, Minnesota Conservation Department.

2/ This volume includes purchases of dimension and blocking. Its standard error is ± 20 percent--that is, there are 2 chances in 3 that the estimate does not deviate from the true but unknown figure by more than ± 10,200,000 board-feet.

JANUARY 1958

JOHN R. WARNER
Research Forester

(Over)

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

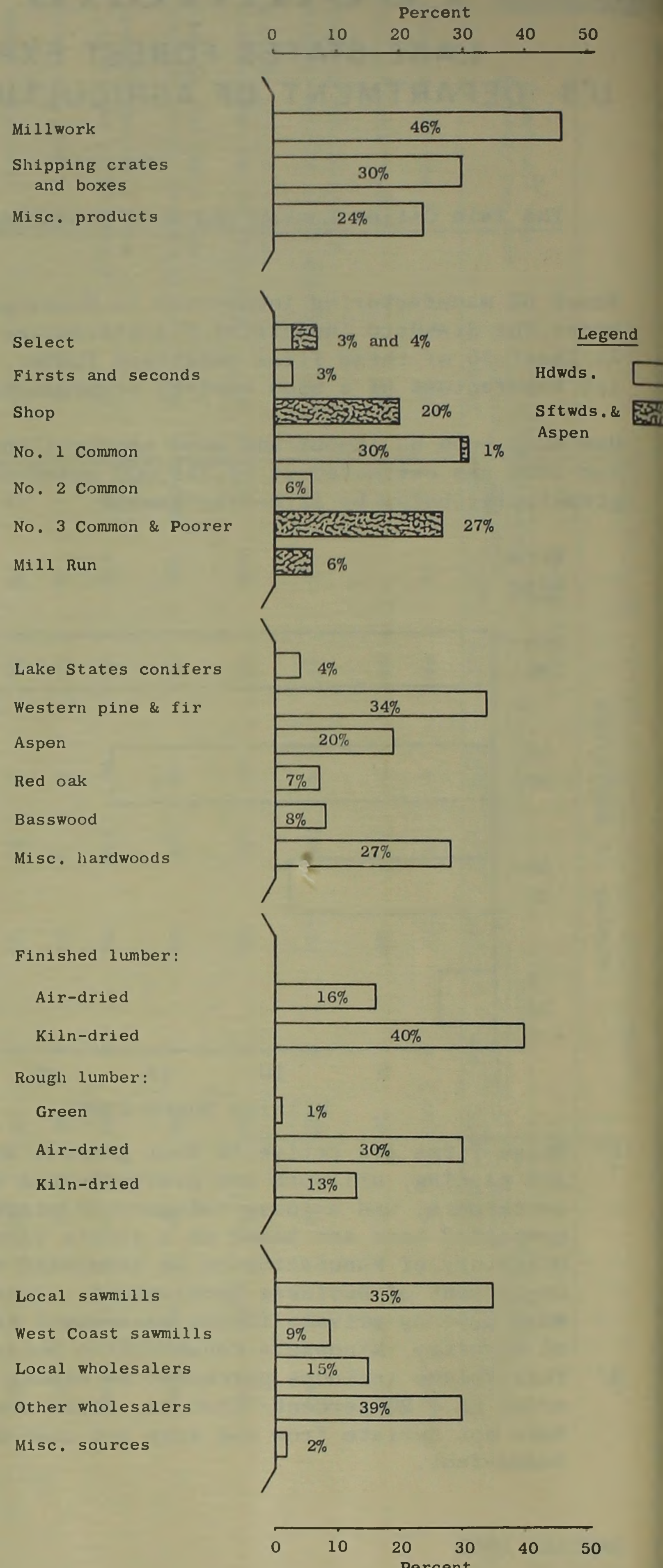
What is the wood used for?
Millwork includes such items as wooden windows and awnings, sashes and doors, precut and prefabricated buildings including homes and cabins. More than 90 percent of the miscellaneous products category was made up of wood used by the cooperage industry.

What quality of wood is used?
Quality requirements were highly variable in millwork uses. On the other hand, cooperage was a steady user of No. 1 Common hardwoods while shipping uses created the major demand for No. 3 Common and Mill Run softwoods.

What species are used?
Wood from species grown in Minnesota and Wisconsin probably made up about half of the total volume used. The millwork category was the largest user of wood from other regions, getting approximately 70 percent of its needs from the West Coast.

In what form is it purchased?
Cooperage was the largest single user of kiln-dry lumber, taking slightly more than one-half of the total reported, with millwork uses running it a close second. A major part of the finished air-dry lumber was also used in general millwork, while most of the rough air-dry was surfaced on two sides after purchase and manufactured into boxes and crates.

Where is it obtained?
Lumber purchases were made almost entirely from wholesalers of different kinds including sawmills. Less than one-quarter of 1 percent of the total volume was purchased at retail. The category "other wholesalers" includes a number of wholesale sources located outside of Minnesota.



TECHNICAL NOTES

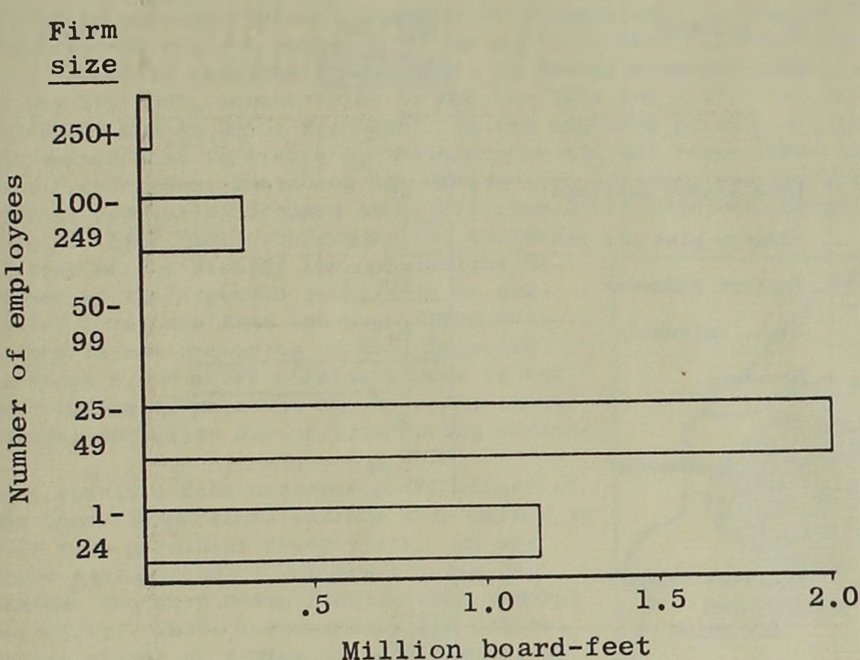
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 518

Miscellaneous Manufacturing Industries in the Twin Cities as Users of Wood

About 200 manufacturing firms in Minneapolis and St. Paul are classified as Miscellaneous Manufacturing Industries.1/ Nearly one-third of these purchased lumber, including dimension and blocking, for product manufacture and shipment during 1956.

How much wood does this industry group purchase?--Estimated purchases of lumber, dimension, and blocking by these firms for 1956 total 3,512,000 board-feet.2/ The volumes purchased by firm-size group are shown graphically below.



Firm size	Firms in sample	Known firms
250+	3	3
100-249	2	10
50-99	4	9
25-49	8	29
1-24	47	146

1/ This is under the Standard Industrial Classification which divides all manufacturing industries into 20 groups. The miscellaneous manufacturing category is made up of firms producing items such as jewelry, buttons, and notions, plastic products, marking devices, window shades, toys, sporting and athletic goods, and a host of other miscellaneous products. Estimates published here are based on a sample taken from the 1955 Minnesota Directory of Manufacturers as tabulated and published by the Minnesota Department of Business Development. Interviews with the sample firms were made by private forest management Service Foresters of the Division of Forestry, Minnesota Conservation Department.

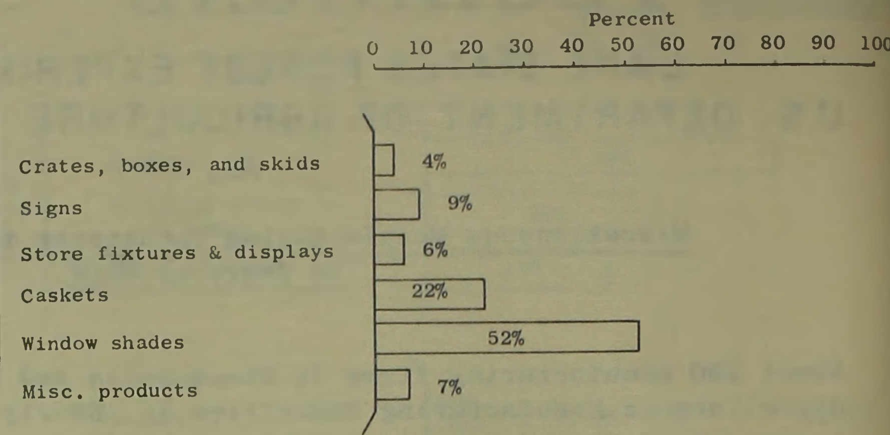
2/ The standard error of this volume estimate is 48 percent--that is, there are 2 chances in 3 that the true but unknown purchased volume lies within ± 1,700,000 board-feet of this figure. Improved sampling techniques, developed in this pilot survey, would reduce the sampling error on a repeat coverage of this industry group.

JANUARY 1958

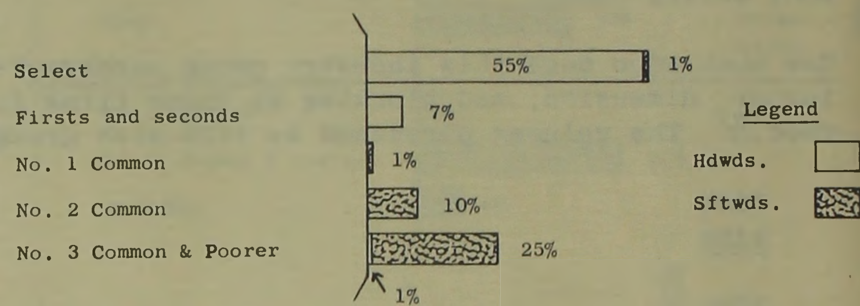
JOHN R. WARNER, Research Forester

(Over)

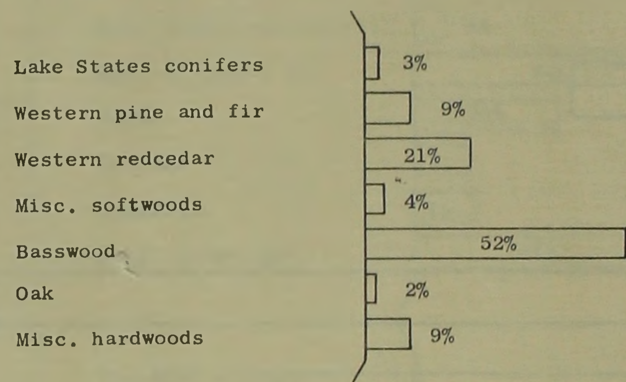
What is the wood used for?
Product manufacture in one form or another accounted for more than 95 percent of all purchases. Products, for the most part, were small and light enough to make efficient use of cardboard cartons for shipment. Thus, only about 3 percent of lumber purchases were used in shipping.



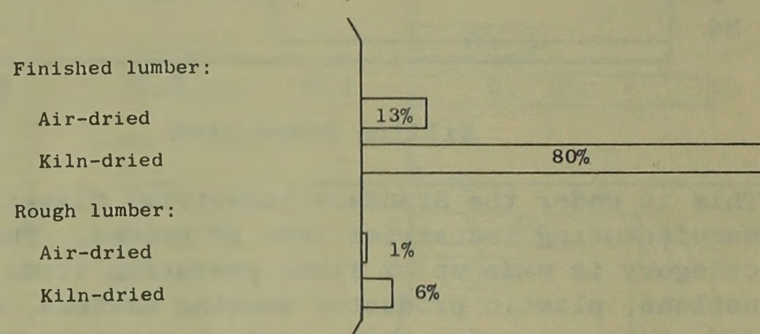
What quality of wood is used?
Quality extremes appear to have made up the bulk of wood purchases, reflecting many specialty uses. The preference for high or low quality depends on the use of wood for show pieces or as hidden supports.



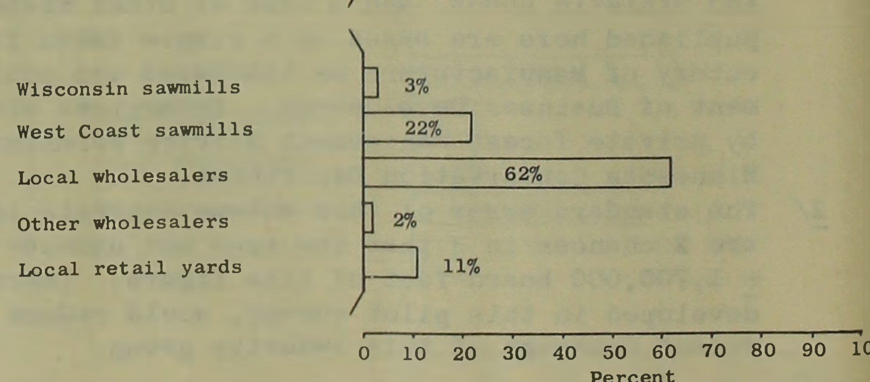
What species of wood are used?
Because of specialty uses such as stamp blocks, window shade cases, and store displays, which require machining, narrow density margins, or the ability to take a high polish, 63 percent of the wood used was hardwood. Twenty-one percent, or well over half of the softwood group, was Western redcedar and was used in the manufacture of caskets.



In what form is it purchased?
Because a large number of specialty products are manufactured for the final consumer, these companies prefer well-dried, finished lumber.



Where is it obtained?
Probably 50 percent of the lumber purchased was grown and processed in Minnesota or Wisconsin and sold through metropolitan lumber yards on both a wholesale and retail basis. Western redcedar used in caskets was the source of all direct West Coast sawmill shipments.



TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 519

Some Effects of Temperature Extremes on Saratoga Spittlebug Populations

The Saratoga spittlebug, first reported as a plantation pest in Wisconsin and Lower Michigan in 1941, is one of the most important insects affecting young red pine plantations in the Lake States. Damage is caused by adult feeding on the needle-bearing branches, resulting in necrotic scars in the cortex, twig mortality, and eventually death of the tree. Until the trees are about 15 feet tall a constant vigil must be kept by forest managers to detect potentially dangerous infestations. Control needs are estimated a year in advance on the basis of adult populations. Sometimes, however, the predicted and actual control needs differ considerably. This Note presents some clues as to the possible reasons for discrepancies in 1956 and 1957.

Early investigators learned through laboratory experiments that young spittlebug nymphs were killed by momentary direct exposure to temperatures in the low 20's (Fahrenheit). Such air temperatures are not uncommon in the northern Lake States areas during May; where they persist long enough to penetrate the duff it is likely that spittlebug populations will be decimated. On May 16, 1957, temperatures in the low 20's and lower were recorded in the northern part of Wisconsin and in Upper Michigan. In the southern portion of the Nicolet National Forest, below the dotted line in figure 1, temperatures did not reach these lethal levels. In the northern hard-freeze area, including the Chequamegon, Ottawa, and Upper Michigan National Forests, the nymphal population dropped to levels much lower than were predicted from the 1956 adult surveys (fig. 2, 1957 data) whereas in the southern portion of the Nicolet the populations remained at the expected level. It is suggested therefore that the population drop to levels not requiring control measures on about 6,000 acres of plantations in the more northerly area was due to early instar nymphal mortality during late spring freezes.

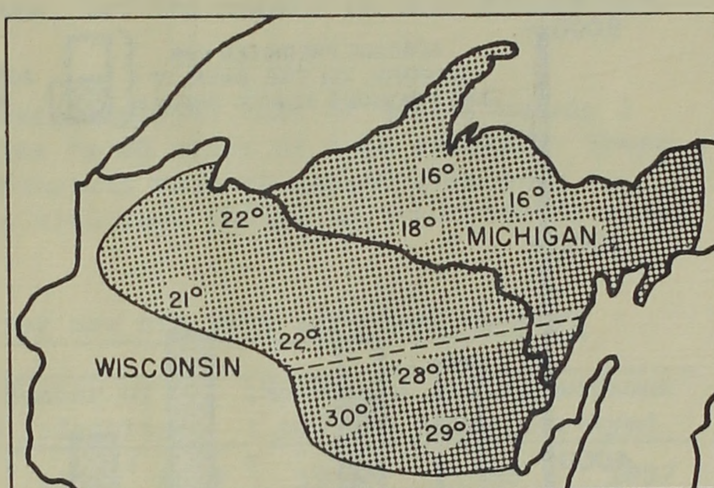


Figure 1.--Minimum temperatures on May 16, 1957, in the spittlebug infested area of northern Wisconsin and Upper Michigan.

More specific data concerning the effect of the other temperature extreme were gained in 1956 from permanent study plots. It was found that periods of abnormally hot dry weather can also cause considerable nymphal mortality. Table 1 summarizes the differential effect of 4 days of such weather on the nymphs in 2 relatively open plantations and 2 well-stocked, heavily shaded plantations. No significant biological control factors were found in any of the plots, and it is tempting to speculate that the population drops in the northern area in 1956 (fig. 2) were due to desiccation during the heat wave. Many of the plantations in the northern forests are relatively more poorly stocked and exhibit more frequent "frost pocket" failures, whereas a more benevolent climate on the Nicolet National Forest tends to promote more rapid growth with denser ground cover.

Although adequate data are not available to afford definite proof, it seems likely that the weather factors mentioned may have been responsible for reducing spittlebug populations in 1956 and 1957 and thus eliminating the need for spraying considerable areas on the National Forests, which had originally been set up for control operations.

January 1958

H. G. EWAN, Entomologist

Table 1.--Nymphal mortality in open and shaded plantations during 4 days of hot dry weather, northern Wisconsin - June 1956

Stand density	No. of tree units per acre1/	Av. daily max. temperature June 10-132/	Nymphal sampling date	Nymphs per 1/10 milacre: Av. no.	Nymphs per 1/10 milacre: Standard error	Percent of initial population
Well stocked, heavily shaded	107,163	91	June 5	6.2	±1.2	--
			June 13	5.5	±1.3	89
	71,285	93	June 5	4.9	±1.5	--
			June 13	4.9	±2.1	100
Relatively open	22,441	90	June 5	8.3	±2.9	--
			June 13	1.6	±1.0	19
	54,220	90	June 5	14.2	±2.5	--
			June 13	1.9	±0.9	13

1/ Measure of tree size and stocking (a product of average tree height (in feet), average number of branch whorls, and number of stems per acre).

2/ From Climatological Data, Wisconsin; U. S. Dept. Commerce Weather Bureau, LXI (6), June 1956.

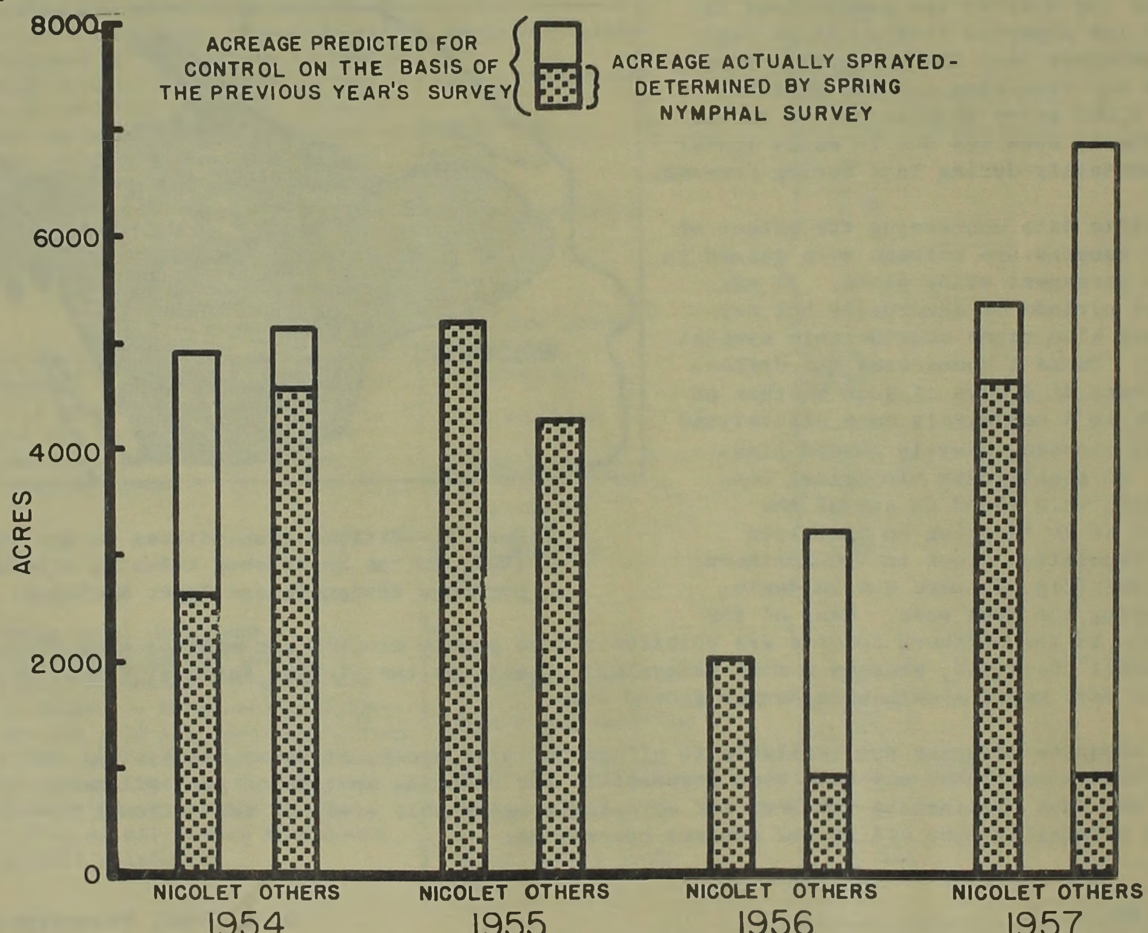


Figure 2.--Acreage predicted for control and acreage actually sprayed on the Nicolet National Forest and other National Forests in Wisconsin and Upper Michigan.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 520

The Long-Distance Spread of Oak Wilt, 1955 to 1957

Oak wilt is a serious disease threatening the oak stands in the Lake States region. New infection centers are continually arising. From them the fungus spreads outward and kills the surrounding timber. By what means the fungus is spread to originate these new centers is not definitely known, but insects apparently are the important means of transmission.

A survey is being conducted in southeastern Minnesota and central Wisconsin to determine the rate of establishment of these new infection centers. The survey consists of driving roads that border oak type and examining all trees on a strip ½-chain wide. All new infections that have arisen since the previous year are recorded. By confining the survey to a narrow strip, the possibility of overlooking a diseased tree is reduced.

During the 3-year period of 1955-57, survey data were collected in 3 Minnesota counties and 2 Wisconsin counties (table 1). The results indicate a somewhat lower rate of infection in Houston and Sherburne Counties in Minnesota as compared to the Wisconsin counties of Adams and Jackson. Washington County in Minnesota had the highest rate, but the sample in this county is very small.

An analysis of the data indicates an establishment rate of approximately 1 new infection annually for each 15 miles or 60 acres of type sampled. These 3-year results indicate a relatively constant rate of spread from year to year and also no apparent relationship with such things as tree size or stand density.

Table 1.--Establishment rate for new oak wilt infection centers

County	Miles of ½-chain-wide oak strips examined	Number of new infections			Number of new infections per 100 acres surveyed		
		1955	1956	1957	1955	1956	1957
Houston, Minn.	32.1	1	2	1	0.8	1.6	0.8
Sherburne, Minn.	91.7	6	4	3	1.6	1.1	.8
Washington, Minn.	16.0	3	4	2	4.7	6.3	3.1
Adams, Wis.	110.6	6	9	8	1.4	2.0	1.8
Jackson, Wis.	64.7	5	4	6	1.9	1.5	2.3
Total or average	315.1	21	23	20	1.7	1.8	1.6

GERALD W. ANDERSON, Research Forester
RALPH L. ANDERSON, Plant Pathologist

January 1958

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 521

The Local Spread of Oak Wilt, 1955 to 1957

Oak wilt is causing serious timber losses in the Lake States region. Once established in a location it spreads radially to the surrounding trees by means of the natural root grafts which often exist between adjacent trees. These connecting links permit the fungus to pass from one tree to another and cause the characteristic circular pattern of infection. The oldest infected tree is at the center, and the most recently infected trees are in a ring at the outer edge.

An annual survey is being conducted in central Wisconsin and southeastern Minnesota to measure the increase in size of established oak wilt infection centers. Permanent stakes are set at the center of infected areas, and the distance to the outer edge is measured annually along the cardinal directions. Only infection areas in which it is possible for the disease to spread in at least three directions were selected for this survey.

A comparison of 2 years' results indicates no great change in spread from year to year. The overall rate of spread was about 1 foot greater in 1957 than in 1956 (table 1). The greatest increase in 1957 apparently occurred in Houston County, Minn., but the 1956 sample for Minnesota counties was too small for such a comparison to be valid.

Table 1.--Activity within established oak wilt infection centers

County	Year	Total number of centers	Active centers: Number	Active centers: Percent	Av. radial spread in feet for: Active centers	Av. radial spread in feet for: All centers
Washington and	1956	3	1	33	11.3	3.8
Sherburne, Minn.	1957	13	8	62	6.6	4.0
Houston, Minn.	1956	7	5	71	4.4	3.1
	1957	17	11	65	11.1	7.2
Adams, Wis.	1956	15	11	73	7.2	5.3
	1957	23	16	70	8.3	5.8
Jackson, Wis.	1956	12	3	25	5.7	1.4
	1957	24	5	21	6.7	1.4
All	1956	37	20	54	6.5	3.5
	1957	77	40	52	8.5	4.4

The overall percentage of infection centers with active wilt was about 50 percent for both years (table 1). For both years all counties with more than 7 samples, except Jackson County, Wis., had active wilt in from 60 to 70 percent of the centers. Jackson County, with only 25 percent in 1956 and 21 percent in 1957, shows a marked deviation from the pattern for other counties. The reason for or permanency of this difference is unknown.

Additional plots were established during 1957, and they will be included in the remeasurement scheduled for 1958.

GERALD W. ANDERSON, Research Forester
RALPH L. ANDERSON, Plant Pathologist

January 1958

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 522

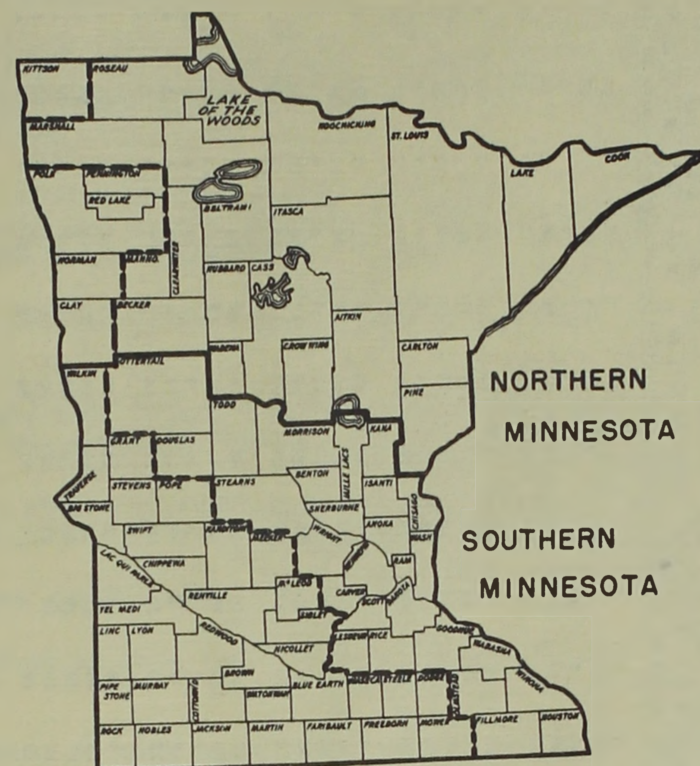
Net Timber Volume by Species and Counties on Commercial Forest Land in Minnesota[1]

The board-foot volume of sawtimber and the cordwood volume of poletimber for Minnesota counties are presented below.

Table 1 covers 19 individual counties and a group of 6 counties in the Red River Valley District in the northern part of Minnesota. Table 2 covers 27 individual counties in central and southeastern Minnesota and 35 primarily farming counties combined in the southwest.

The northern half of the State contains more than 69 percent of the volume in live sawtimber and close to 87 percent of the poletimber volume. It has over 98 percent of all conifer volume and over 90 percent of all aspen. The southern part of the State has mostly hardwood timber.

These figures are from the Forest Survey of Minnesota made during 1947-53 by the Office of Iron Range Resources and Rehabilitation Commission, the Lake States Forest Experiment Station, and other cooperators.



1/ Individual counties in the Red River Valley and Southwest District are combined together because of the relatively small commercial forest area.

Table 1.--Net timber volume on commercial forest land[1]
Northern Minnesota

County	Total		White and red pine		Jack pine		Black and white spruce		Balsam fir		Tamarack and white-cedar		Aspen		Paper birch		Red and bur oak		Other[2] hardwoods	
	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords	MM 3/ Bd.ft.	M 4/ Cords
Aitkin	324	1,888	27	14	5	8	4	117	13	109	10	249	90	545	11	114	18	80	146	652
Becker	175	1,313	30	27	17	137	6	45	5	65	5	41	33	501	3	90	19	140	57	267
Beltrami	464	3,084	95	63	46	255	32	290	20	196	34	449	69	991	22	192	13	79	133	569
Carlton	79	762	23	18	8	21	3	42	2	40	*	31	6	377	4	57	4	21	29	155
Cass	830	3,375	263	136	104	402	18	117	28	198	37	351	160	1,199	36	336	39	301	145	335
Clearwater	177	1,480	22	11	22	93	12	89	10	31	14	98	52	783	3	78	8	89	34	208
Cook	1,019	2,699	183	96	163	255	216	643	99	452	110	125	131	583	92	467	-	-	25	78
Crow Wing	211	1,107	48	39	65	336	1	17	*	7	6	31	37	286	1	54	26	233	27	104
Hubbard	114	1,169	32	31	46	356	3	37	2	19	2	27	10	520	*	53	6	62	13	64
Itasca	1,253	5,403	306	155	69	319	47	505	79	546	74	392	369	2,343	92	473	58	159	159	511
Koochiching	781	5,137	78	15	21	118	185	2,016	71	613	121	727	174	955	27	169	6	3	98	521
Lake	905	4,021	153	96	316	763	138	823	54	451	40	152	109	809	52	666	-	**	43	261
Lake of the Woods	206	1,966	3	4	41	293	39	672	13	81	37	350	38	314	15	67	*	**	20	185
Mahnomen	64	497	2	**	13	31	1	4	*	4	1	4	6	235	1	17	10	56	30	146
Marshall	52	396	1	-	*	2	1	9	*	2	*	6	3	170	1	11	14	56	32	140
Pine	147	1,011	8	6	1	6	1	8	2	22	*	16	29	520	5	90	25	80	76	263
Roseau	78	821	2	-	20	157	3	167	1	18	5	66	4	199	2	16	5	26	36	172
St. Louis	1,580	11,389	393	395	442	1,823	119	1,079	101	1,142	42	466	320	4,812	20	850	5	24	138	798
Wadena	38	323	3	6	10	131	3	4	1	6	*	6	4	76	*	19	4	36	13	39
Other Red River Valley counties[5]	199	929	*	**	-	-	*	6	1	6	1	9	12	438	3	28	36	157	146	285
Total No. Minn.	8,696	48,770	1,672	1,112	1,409	5,506	832	6,690	502	4,008	539	3,596	1,656	16,656	390	3,847	296	1,602	1,400	5,753

(Footnotes for tables 1 and 2 have been combined and are below table 2 (other side of sheet).

MINNESOTA IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 2.--Net timber volume on commercial forest land[1/]
Southern Minnesota

County	Total		Conifers		Sugar maple		Basswood		Amer., rock, and slip. elm		Red oak		White and bur oak		Asp., bal.pop. & pap. birch		Cottonwood		Other[6/] hardwoods	
	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords	MM 3/ Bd.-ft.	M 4/ Cords
Anoka	31	153	1	7	1	2	2	9	3	6	13	57	9	37	1	23	*	-	1	12
Benton	22	139	1	1	*	7	2	19	4	12	6	23	6	21	2	38	*	-	1	18
Carver	85	38	-	-	10	7	20	5	23	8	15	5	7	5	1	1	1	**	8	7
Chisago	159	224	6	10	4	10	28	23	51	22	24	37	20	36	2	34	*	-	24	52
Dakota	77	61	-	-	8	8	14	4	18	7	22	21	7	12	*	4	1	**	7	5
Douglas	65	196	1	8	3	18	22	27	8	10	16	32	10	27	2	62	*	-	3	12
Fillmore	223	331	2	1	3	8	21	22	22	23	122	139	37	80	2	26	2	1	12	31
Goodhue	129	229	*	-	2	5	17	19	24	19	50	79	16	42	1	26	5	3	14	36
Hennepin	83	55	-	1	10	8	18	5	19	8	19	11	8	9	*	3	1	**	8	10
Houston	315	430	1	1	4	11	24	25	35	34	175	181	53	107	2	27	4	1	17	43
Isanti	64	206	6	15	1	3	4	14	7	9	24	68	18	51	2	30	*	-	2	16
Kanabec	51	473	3	13	1	5	5	23	10	23	10	115	7	39	11	216	1	-	3	39
Le Sueur	68	43	-	-	8	8	14	3	17	7	15	11	6	7	*	3	1	**	7	4
Mille Lacs	130	539	8	29	7	18	26	58	25	38	22	52	13	50	12	216	1	-	16	78
Morrison	122	612	20	39	2	8	18	35	23	36	23	93	16	77	12	259	-	-	8	65
Olmsted	127	170	*	**	2	5	12	15	16	13	68	70	20	40	1	10	1	**	7	17
Otter Tail	302	782	16	66	11	37	68	112	76	63	51	100	42	101	12	203	1	-	25	100
Ramsey	13	14	*	-	1	1	2	1	2	1	6	4	1	2	*	1	*	**	1	4
Rice	46	38	-	-	5	5	9	2	9	4	15	14	4	7	*	3	*	**	4	3
Scott	76	47	-	-	8	7	12	3	25	9	15	14	6	7	*	3	2	**	8	4
Sherburne	41	153	*	4	1	2	4	9	10	8	12	60	9	34	2	21	*	-	3	15
Stearns	133	333	3	21	3	14	28	48	31	28	29	66	22	53	4	57	1	-	12	46
Todd	111	401	11	49	4	9	15	34	19	26	30	76	18	64	5	99	1	-	8	44
Wabasha	126	226	*	**	2	6	18	19	17	17	59	80	19	46	2	35	2	**	7	23
Washington	43	111	*	6	3	5	3	10	3	4	23	34	8	31	1	14	*	-	2	7
Winona	266	402	3	1	4	10	23	26	28	26	143	170	43	100	3	28	4	1	15	40
Wright	120	129	1	1	10	9	37	25	38	19	11	12	8	17	2	11	*	-	13	35
Southwest counties[7/]	814	805	2	5	9	18	89	107	216	151	46	34	140	154	*	21	142	34	170	281
Total So. Minn.	3,842	7,340	85	278	127	254	555	702	779	631	1,064	1,658	573	1,256	82	1,474	171	40	406	1,047

1/ Forest land that is (1) producing, or physically capable of producing, usable crops of wood (usually sawtimber); (2) economically available now or prospectively; and (3) not withdrawn from timber utilization.
2/ Primarily soft maple, yellow birch, basswood, American elm, slippery elm, balsam poplar, black ash, and green ash.
3/ Net volume in million board-feet, International 1/4-inch Log Rule, of live sawtimber trees.
4/ Net volume in thousand cords of live poletimber trees from stump to a minimum merchantable 4.0 inch top diameter. Excludes dead trees, cull trees, and hardwood limbs.
5/ Includes: Clay, Kittson, Norman, Pennington, Polk, and Red Lake Counties.
6/ Primarily soft maple, black ash, green ash, boxelder, willow, black cherry, hickory, hackberry, black walnut, and butternut.
7/ Includes: Big Stone, Blue Earth, Brown, Chippewa, Cottonwood, Dodge, Faribault, Freeborn, Grant, Jackson, Kandiyohi, Lac qui Parle, Lincoln, Lynn, Martin, McLeod, Meeker, Mower, Murray, Nicollet, Nobles, Pipestone, Pope, Redwood, Renville, Rock, Sibley, Steele, Stevens, Swift, Traverse, Waseca, Watonwan, Wilkin, and Yellow Medicine Counties.
* Less than 1/2 million board-feet.
** Less than 500 cords.

APRIL 1958

ALEXANDER M. VASILEVSKY, Forester
Office of Iron Range Resources and Rehabilitation and
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TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 523

Cutting Methods Affect Snow Accumulation and Melt in Black Spruce Stands

The black spruce bog type covers over a million acres of land in northern Minnesota. To learn something about the influence of different cutting methods in black spruce on the snowpack in this northern region, a study was initiated on the Big Falls Experimental Forest near Big Falls, Minn., during the winter of 1956-57.

Prior to cutting, the black spruce stand, located on peat soils, had a basal area of 110 to 140 square feet per acre in trees 4 inches and up. A majority of the cordwood volume was in trees 5 to 9 inches in diameter. The following cutting methods were studied:

A clear-cut strip 66 feet wide and 396 feet long. The strip was oriented east and west.

A shelterwood cut that left 51 square feet of basal area in scattered trees 1 inch and up. Most of the volume was in trees 7 and 8 inches in diameter.

Individual tree selection that left about 75 square feet of basal area. A large share of the volume was left in trees 6 to 8 inches in diameter.

Open. This was a clear-cut patch of approximately one-half acre.

Uncut stand containing 132 square feet of basal area in trees 4 inches and up.

Ten observations of snow depth and water content were made periodically in each of these stands between February 14 and April 16.

During the period of snow accumulation, which began with the first snowfall in December and lasted until early March, the effect of crown interception was quite noticeable. The open areas--open patches and clear-cut strips--received the most snow. Next in order was the shelterwood cutting with fairly large holes in the canopy. This was followed by the tree selection method, which had smaller openings. The dense, uncut stand received the least amount of snow on the ground. Figure 1 (on the back of the sheet) traces the accumulation and melt of snowfall under each of the stand conditions.

During the period of melt, early March to mid-April, the role of the forest canopy in preventing melt became dominant. The local microclimate, which the forest creates, affected the order of melt. The open patch, which was exposed to direct rays of the sun, lost its moisture most rapidly by sublimation and melt. This was followed by the shelterwood system, the check area, tree selection area, and the clear-cut strip. The actual amount of water in the snowpack is shown in table 1.

Although these data were obtained during only one season, it appears that cutting narrow, east-west strips may result in a high total accumulation of snow and a reduced rate of melt in the spring. They accumulate snow very much like open areas, but during the melt period, the narrow strips are protected from direct rays of the sun by tall trees on the southern border. Large openings, which are exposed to direct sunlight, lose their snow most rapidly. Silvicultural systems that open up the stand to some intermediate degree are intermediate in their ability to catch snow and prolong snowmelt in the spring.

APRIL 1958

ROGER R. BAY
Forester

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Figure 1.--Depth of snowpack under various cutting methods in black spruce.

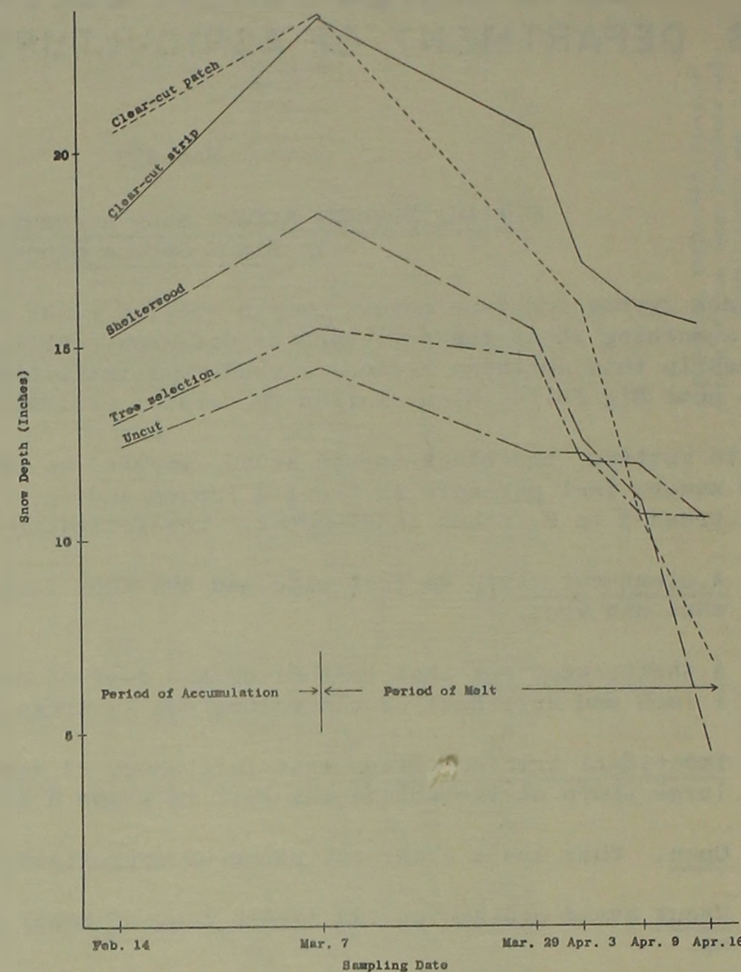

Table 1.--Water content of snowpack under various cutting methods in black spruce

(Inches of water)

Date	Cutting method				
	Clear-cut strip	Single tree selection	Uncut unit	Shelterwood	Open patch
February 14	2.9	2.0	1.6	2.2	2.9
March 7	4.0	2.6	2.5	3.2	4.5
March 29	4.3	3.2	2.7	3.5	4.0
April 3	4.2	2.8	2.7	2.9	3.6
April 9	3.6	3.2	2.7	2.8	2.4
April 16[1/]	3.2	2.9	2.5	1.8	1.5

1/ This was the last sampling date. Exceptionally high temperatures combined with heavy rains melted all snow by April 25.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 524

A Red Pine Plantation Problem in Upper Michigan

Many red pine plantations in the western half of the Upper Peninsula of Michigan have suffered from poor growth and mortality during the last few years. Although the Saratoga spittlebug was suspected at first, observations did not provide any conclusive evidence that either insects or diseases were primary factors. Because of this, and the inconsistency of injury on the trees and within the plantations, a survey was made for the purpose of identifying major symptoms and their pattern of occurrence.

A sample of 13 pure red pine plantations on the Kenton Ranger District of the Ottawa National Forest provided the data on 924 live and 519 dead trees out of a possible 3,160. The survival in these plantations, which were randomly selected from three age classes, indicates that the most losses are in the youngest group, those planted 5 to 9 years ago. Older plantations, 10 to 14 years since planting and 15 years or older, had poor survival (about 40 percent), but were more than three times as successful as the youngest age group with only 13 percent. Survival in the 5- to 9-year age group was closely related to seed source as shown in table 1. Not so marked was the correlation of survival with seed source in the older age groups: 49 percent with the Ottawa National Forest seed source, 44 percent with Chippewa, 31 percent with Upper Michigan, and 20 percent with the Lower Michigan seed source.

Table 1.--Survival and major symptoms in 5- to 9-year-old red pine plantations by seed source

Seed source (National Forest)	Area	Survival	Symptoms on live trees		
			Dead branch	Canker	Dead top
	Acres	Percent	Percent	Percent	Percent
Ottawa	44	32	57	28	17
Upper Michigan	70	16	53	51	42
Chippewa	166	8	47	67	54
All	280	13	52	48	37

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The three most common symptoms were dead branches, cankers, and dead tops. Table 1 shows the distribution of these symptoms by seed sources. Other conditions found in these plantations were bent trees, sharp decreases in growth, broken branches, and insect damage. However, they were noted so infrequently that they cannot be considered characteristic of the major problem.

Dead branches occurred uniformly in all three seed sources, but were much more frequent on exposed trees. Possibly they are associated with the severe winters typical of this area rather than with poor survival. They are, however, the principal condition contributing to the unhealthy appearance of these plantations.

A canker, which apparently girdles the branches as well as the stems, was the second most frequent symptom. It was also observed on nearly 40 percent of the dead trees. As detection is difficult because canker symptoms are largely limited to necrosis of the inner bark, it is certain that the estimates are conservative. The canker was more common in seed sources with lower survivals. It was general on all topographic positions but most common on flats and south slopes and was found equally on exposed and protected trees.

Dead tops, the third most frequent symptom, were also related to seed source. They were distributed evenly on all aspects except the west slopes where they were less common. Although dead tops and cankers were both found more frequently in seed sources with lower survivals, the relationship between these two symptoms could not be clearly determined from this survey.

Since the cankers were detected in these failing plantations, they have also been noted in some plantations further east. In all cases, they are more common on young trees. Because it occurs in significant amounts and is apparently associated with survival, the next step in this problem is to identify the canker and determine its role in these plantations.

April 1958

JOHN W. BENZIE, Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 525

Height Growth is Indicative of the Relative Frost Resistance of Hemlock Seed Sources

A study of 17 eastern hemlock seed sources, planted in the Hugo Sauer Nursery at Rhinelander, Wis., showed that southern sources grew later into the fall and were more damaged by frost than their northern counterparts. In earlier experiments with controlled photoperiods, southern warm-climate sources showed greater total elongation because of inherent ability to grow over a longer season rather than because of a faster growth rate.1/2/ Hence, the results of the present experiment suggest that relative frost resistance can be predicted with reasonable accuracy from small indoor tests of growth performance.

The study was conducted by the Northern Institute of Forest Genetics in cooperation with the Connecticut Agricultural Experiment Station. Four-year-old seedlings of 17 seed sources covering the greater part of the range of eastern hemlock were planted on May 17 in two randomized blocks. The majority of the sources were represented by 16, 20, or 24 trees in each block, depending on the number of parent trees of each source entered in the experiment.

The first seasonal frost was in the early morning of September 5, when the temperature dropped to -5° C. (23° F.).3/ From this date until the frost injury data were collected on October 29, freezing temperatures were recorded on 32 nights, with the temperature dropping to -7° C. (20° F.) or less on 6 nights. Four arbitrary classes of injury were recorded: (1) no injury; (2) slight injury--only the very tips of the shoots damaged, the terminals usually healthy; (3) moderate injury--shoots killed back ½ to 1 inch; and (4) severe injury--more than 1 inch of the shoots killed. Each individual plant was ranked according to these classes and an average computed for all plants of each source.

There is, as could be expected, a close statistical correlation between the amount of frost injury at Rhinelander (with an average growing season of 123 days) and the length of growing season at the point of origin of the stock (fig. 1). Furthermore, there is a highly significant correlation between the total amount of elongation as determined from earlier experiments under controlled conditions of a 15-hour daylength and 17° C. (65° F.)2/ and the amount of frost injury (fig. 2). In the earlier experiments it was shown that elongation is primarily a function of the duration of growth rather than the rate with which the plants of a given seed source grow. Therefore, small indoor tests of the growth performance of different seed sources should permit fairly accurate predictions of their relative frost resistance. Real frost resistance could be determined by field testing only a few key sources.

1/ Olson, Jerry S., and Nienstaedt, Hans. Photoperiod and chilling control growth of hemlock. Sci. 125(3246): 492-494. 1957.

2/ Nienstaedt, Hans, and Olson, Jerry S. Effects of photoperiod on seedling growth of thirty seed sources of eastern hemlock. Unpublished manuscript, The Conn. Agr. Expt. Sta.

3/ Weather data through the courtesy of H. E. Berndt, Manager, Hugo Sauer State Nursery, Rhinelander, Wis.

April 1958

HANS NIENSTAEDT, Geneticist

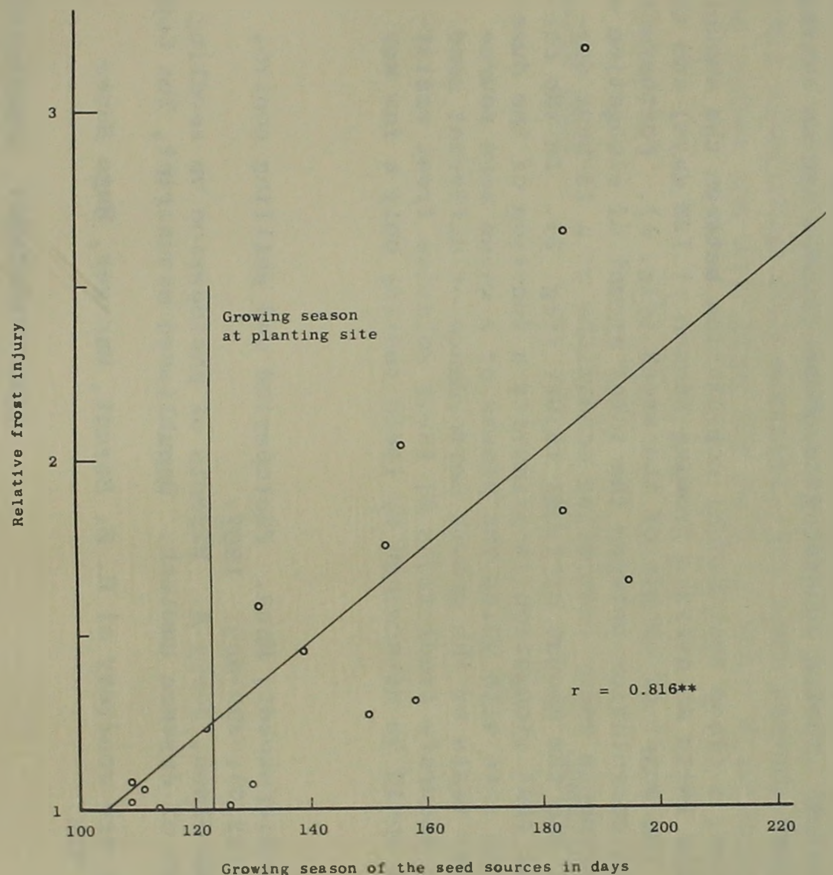


Figure 1.--Correlation between growing season and frost injury for 17 eastern hemlock seed sources at Hugo Sauer Nursery, Rhinelander, Wis. Relative frost injury was computed as the average of all trees in each seed source where 1 equals no injury; 2, slight injury; 3, moderate injury; and 4, severe injury. The double asterisk indicates a significant correlation at the 1-percent level.

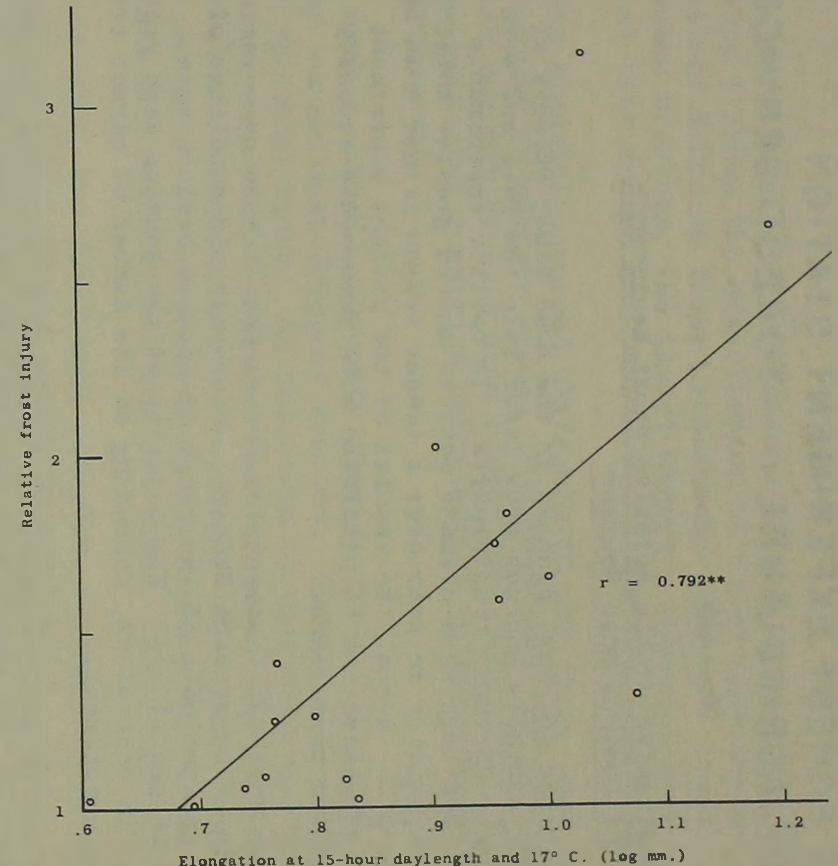


Figure 2.--Correlation between elongation under controlled conditions and frost injury for 17 eastern hemlock seed sources at the Hugo Sauer Nursery, Rhinelander, Wis. Relative frost injury and the double asterisk are defined in fig. 1.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 526

Growth, Vigor, and Mortality of Residual Hemlock-Hardwood Following a Partial Cutting

Partial cutting in mature hemlock-hardwood stands in Upper Michigan may result not only in greater mortality but also in greater growth for the hemlock than for the northern hardwood species, according to 12-year results of a study conducted in cooperation with the Cleveland Cliffs Iron Company.

In 1944 a mature hemlock-hardwood stand north of Marquette, Mich., near Lake Superior, was cut selectively, removing 70 percent of the gross volume. Post-logging mortality and changes in vigor and growth rate were studied in 198 trees. Annual inspections were made until 1952, and a final measurement was taken in 1957.

The partial cut affected the vigor classes of hemlock only during the first 7-year period (table 1). The low-vigor trees and the poorest of the normal vigor trees were largely eliminated through mortality before 1951. The vigor of the hardwoods (yellow birch and others) continued to fluctuate throughout the entire 12-year period. Apparently the hardwoods withstood the shock of heavy cutting better than the hemlock, but effects lasted over a longer period.

Table 1.--Percentage of trees in three vigor classes1/

Years after cutting	Hemlock (95 trees)			Yellow birch (53 trees)			Other2/ (38 trees)		
	N	F	D	N	F	D	N	F	D
2	98	0	2	96	4	0	100	0	0
7	89	1	10	90	8	2	97	0	3
12	88	2	10	92	2	6	84	13	3

1/ Vigor classes: N = Normal; F = Failing; D = Dead.
2/ Sugar and red maple only; excludes 12 miscellaneous conifer trees.

The first 7 years' mortality, reported in Technical Note No. 380, was slight. During the next 5-year period the only mortality was two yellow birch trees, which possibly died in 1954 when yellow birch top-dying was reported in Upper Michigan (Technical Note No. 444).

(over)

Average diameter growth of normal trees showed a definite change in the last 5-year period (table 2); hemlock increased at the same time that hardwoods declined.

Table 2.--Average 5-year diameter growth for trees classed as normal throughout the 12-year period

Species	Number of trees	Diameter growth in inches	
		1946-51	1952-57
Hemlock	83	0.83	0.99
Yellow birch	46	.86	.79
Other[1]	32	.94	.84

1/ Sugar and red maple only; excludes 12 miscellaneous conifer trees.

The increased growth rate of hemlock indicates that the vigor of trees classed as normal improved between 1951 and 1957 and may reflect the elimination of poorer trees from the class, the increased growing space per tree, and recovery from the shock of cutting.

Although mortality losses in this study were very light, the results corroborate the currently recommended practice of a salvage operation 3 to 5 years after the initial cut, but indicate that the hardwoods need the salvage operation as well as the hemlock.

April 1958 ROBERT L. CROSS, Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 527

Changes in Yellow Birch Top-Dying
Upper Michigan 1954-1957

Fourth-year data from observation plots on the Upper Peninsula Experimental Forest at Dukes, Mich., show that the progress of top-dying in yellow birch, first reported in Technical Note No.444, is related to the intensity of cut. The proportion of trees with top-dying reached a peak in virgin and moderately cut stands within a year after the initial injury and is now definitely decreasing. In heavily cut stands with less than 50 square feet of residual basal area, the top-dying continued to increase until the third year where it is now stabilized (fig. 1 on back of sheet).

These data are based on observations of 180 trees (both injured and uninjured) selected at random in virgin and moderately cut stands and on 129 trees in heavily cut stands.

Crown deterioration in the heavily cut stands seems to follow the general pattern of postlogging decadence in that it increases with the intensity of the cut. It is noteworthy that the injury first appeared in both cut and uncut stands at the same time in 1954, the second growing season after logging. The role of exposure, although not the only factor involved, is not definitely known. It appears to be a secondary factor that intensifies a generally adverse physiological situation. This is further indicated by the negligible numbers of the bronze birch borer and absence of disease on the affected trees.

The three diameter-size groups observed, 5-9, 10-14, and 15 inches and larger, all showed the same general trend in progress of top-dying in all stands. The 15-inch-and-larger class has a higher percentage of injured trees, but the smaller size classes have the most serious injury and greatest amount of mortality. Death of the smaller trees generally occurred within 1 year after the initial attack while that of the larger trees has been more gradual. Some trees in all size classes have shown improvement. This trend has been more rapid in the smaller diameters. Since the crown deterioration has stabilized, the recovery probably will become more rapid as the dead branches break out of the tops.

Initially the top-dying may have been caused by a prolonged high water table during the beginning of the 1954 growing season that caused heavy rootlet mortality. Analysis of available water table levels dating back to 1945 show that 1954 has been the only recent year with an extended high-level period. During this year high water levels extended from late March to early June with relatively minor fluctuations, rather than showing the usually steady decline from early April. A series of shallow wells, established on the Experimental Forest after the injury was observed, show that the water table is commonly within 6 inches of the soil surface at the beginning of the growing season. These observations are being continued to determine the correlation of water table fluctuations with tree behavior and stand conditions.

April 1958 (over) R. M. GODMAN, Forester

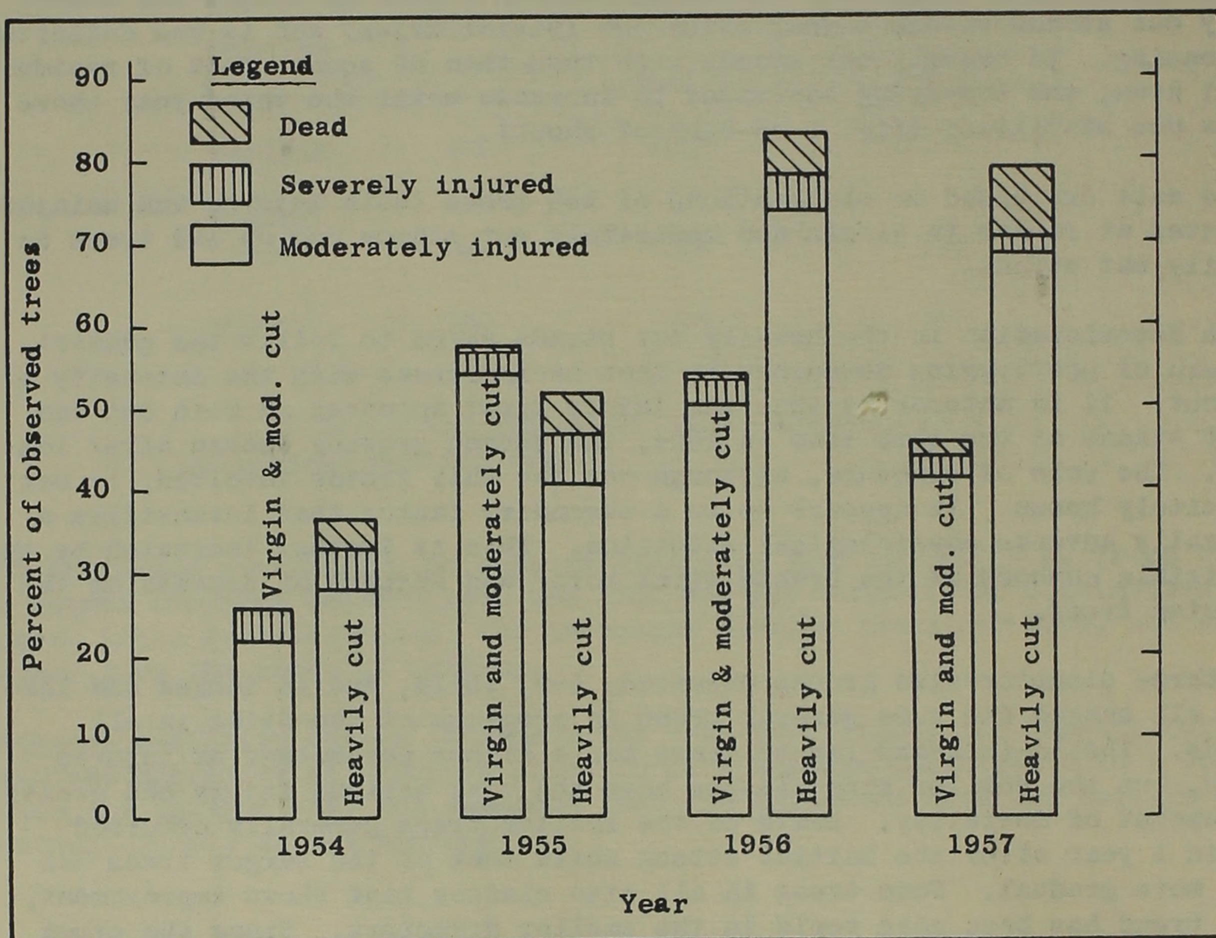


Figure 1.--Annual changes in percent of yellow birch trees with top-dying, and severity of injury by intensity of cut. Severely injured trees are those with more than half of the crown dead but with at least one trunk sprout. Moderately injured trees have dead twigs or branches that constitute less than one-half of the crown.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 528

Fungi Associated With Decay in Sugar Maple Following Logging Injury 1/

Interest in the silviculture of sugar maple and the fungi that attack the tree in the Lake States following partial cutting practices is increasing. Organisms that infect logging scars in northern Michigan maple differ from those that ordinarily produce defect in undisturbed forests. This fact was established during the dissection and examination of 252 trees with 10- and 20-year-old logging scars at the Upper Peninsula Experimental Forest, Dukes, Mich. At least three organisms that cause much decay in virgin stands (*Fomes igniarius nigricans* (L.) Gill., *F. connatus* (Weinm.) Gill., and *Hydnum septentrionale* (Bull.) Fr.) were not isolated.

Daedalea unicolor Bull. ex Fr., on the other hand, developed serious losses in maples with both 10- and 20-year-old logging wounds. It caused an average cull of 16 board-feet (table 1) within 10 years after the trees were scarred.

Table 1.--Rate of decay associated with certain fungi isolated from sugar maple with logging scars 10 and 20 years old Upper Peninsula Experimental Forest, Dukes, Mich.

Age class of injury	Species of fungus	Scars infected	Average decay measurement: Depth	Width	Length	Average amount of cull
		Number	Inches			Board-feet
10-year-old scars	*Daedalea unicolor*	8	5	5	87	16
	Corticium vellereum	1	7	4	97	1/ 22
	Tricholoma unifactum	1	6	5	341	66
	Polyporus versicolor	2	7	5	86	45
20-year-old scars	*Daedalea unicolor*	1	9	14	87	70
	Corticium vellereum	16	5	5	79	1/ 21
	Tricholoma unifactum	1	6	6	58	2/ 30
	Ustulina vulgaris	1	11	11	41	10

1/ *Corticium* not regarded as a primary cause of decay.
2/ Volume of rot limited by size of log. The relatively large amount of decay, however, made the log worthless for a "tie-cut" (cross tie) or lumber.

1/ A cooperative research project of the Laboratory of Pathology in Forest Practice, School of Natural Resources, University of Michigan; and the Lake States Forest Experiment Station.

Corticium vellereum Ell. and Craig.[2/] ranked high in frequency of isolation and was associated with extensive rot traced to 20-year-old logging scars, but it was seldom found in 10-year-old injuries. The generally high incidence corroborates that first reported for sugar maple in Ontario, Canada.[3/] The much more frequent appearance of the fungus in old scars than in 10-year-old wounds strengthens the conclusion reached in a Canadian investigation of rot in Ontario maple.[4/] Corticium vellereum was isolated so commonly that at first this fungus was assumed to be of major importance. It is now believed that the Corticium becomes established in wood already attacked by other organisms and that it is not the cause of a primary decay.

Tricholoma unifactum Pk., not previously associated with rot in living Michigan maple, was isolated from one 10- and one 20-year-old wound (table 1). Fruiting bodies were not seen in the field but were produced in cultures of the organism on maple blocks.

The cultural identification of the specific causes of decay are important to forest pathologists in developing a better understanding of the nature and habits of the fungi causing decay. Fruiting bodies of wood-rotting fungi are so infrequently observed at 10- or even 20-year-old scars with advanced decay that their presence and identity can seldom be used to estimate the extent of decay. The practicing forester, therefore, must base his determination of the extent of decay on wound characteristics rather than on identification of the fungus.

DOW V. BAXTER[5/]
GENE A. HESTERBERG[6/]

April 1958

2/ Cultures identified by Dr. Mildred K. Nobles, Canada Dept. Agriculture, Ottawa.

3/ Nordin, V. J. Studies in forest pathology. XIII. Decay in sugar maple in the Ottawa-Huron and Algoma Extension Forest Region of Ontario. Canad. Jour. Botany 32: 221-258. 1954.

4/ Nobles, Mildred K., and Vidar J. Nordin. Studies in wood-inhabiting Hymenomycetes. II. Corticium vellereum Ell. & Craig. Canad. Jour. Botany 33: 105-112. 1955.

5/ Professor of Forest Pathology and Botany, University of Michigan, and Collaborator, Lake States Forest Experiment Station.

6/ Assistant Professor of Forestry, Michigan College of Mining and Technology, and Collaborator, Lake States Forest Experiment Station.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 529

Lake States Pulpwood Production Remains High--Hardwood Cut Climbs, 1957

Lake States pulpwood production amounted to approximately 2,963,000 cords in 1957. This was 1 percent less than the all-time high of 2,992,000 cords in 1956. Michigan showed a slight increase while Minnesota and Wisconsin were slightly below the production level of the previous year.

Of the regional total, Minnesota produced about 35 percent, Michigan 33 percent, and Wisconsin 32 percent. Production trends show that the proportion of pulpwood from Minnesota has been declining in recent years while the proportion from Wisconsin has been increasing.

Maples, oaks, and other dense hardwoods were cut more heavily for pulpwood than ever before. About one-third of the mills operating in the Lake States used these species in varying amounts. The total cut of hardwoods, excluding white birch and aspen, amounted to 240,000 cords in 1957 compared to 209,000 cords in 1956--an increase of approximately 15 percent. With the exception of aspen, pine, and hemlock, which showed a decline over the previous year, all other species registered an increase.

Total receipts at Lake States mills were 3,532,000 cords, about the same as in 1956. Eighty-four percent was local wood, 14 percent imports from Canada, and 2 percent imports from western states (see following table).

Geographic origin and destination of pulpwood received by Lake States mills, 1957

Species	Percent of pulpwood originating from:					Percent of pulpwood received by:		
	Minn.	Wisc.	Mich.	Canada	Other U. S.	Minn. mills	Wisc. mills	Mich. mills
Aspen	22	35	40	3	-	23	57	20
Balsam fir	42	15	36	7	-	18	62	20
Birch, white	15	63	15	7	-	10	87	3
Hemlock	-	49	51	-	-	-	98	2
Pine	42	24	13	12	9	30	61	9
Spruce	39	3	14	40	4	24	66	10
Tamarack	74	23	2	1	-	41	59	-
Misc. hdwds.	1/ 3	2/ 74	2/ 23	-	-	3	78	19
All species	30	26	28	14	2	21	64	15
Previous year (1956)	30	27	28	12	3	24	61	15

1/ Balsam poplar (balm-of-Gilead).
2/ Mostly dense hardwoods.

A. G. HORN
Forest Economist

APRIL 1958

(Over)

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Production and imports of pulpwood, Lake States, 1957

(In standard cords, unpeeled)

Species and destination	Production by states[1/]				Imports			Total receipts
	Minnesota	Wisconsin	Michigan	Region	Other[2/] U. S.	Canada	Total imports	
Aspen								
Minn.	261,122	15,965	-	277,087	-	14,890	14,890	291,977
Wisc.	16,239	436,867	280,574	733,680	-	5,328	5,328	739,008
Mich.	-	-	239,583	239,583	-	23,920	23,920	263,503
Exported[3/]	-	-	429	429	-	-	-	-
Total	277,361	452,832	520,586	1,250,779	-	44,138	44,138	1,294,488
Balsam fir								
Minn.	74,430	-	-	74,430	-	-	-	74,430
Wisc.	96,320	59,830	96,270	252,420	-	1,089	1,089	253,509
Mich.	1,991	-	51,049	53,040	-	30,295	30,295	83,335
Total	172,741	59,830	147,319	379,890	-	31,384	31,384	411,274
Birch, white								
Minn.	4,250	-	-	4,250	-	267	267	4,517
Wisc.	2,385	27,455	5,355	35,195	-	2,770	2,770	37,965
Mich.	-	-	1,424	1,424	-	-	-	1,424
Total	6,635	27,455	6,779	40,869	-	3,037	3,037	43,906
Hemlock								
Minn.	-	-	-	-	-	-	-	-
Wisc.	-	57,155	58,416	115,571	-	-	-	115,571
Mich.	-	-	2,080	2,080	-	-	-	2,080
Total	-	57,155	60,496	117,651	-	-	-	117,651
Pine								
Minn.	119,637	1,268	-	120,905	-	35,496	35,496	156,401
Wisc.	103,843	124,381	22,344	250,568	48,518	26,360	74,878	325,446
Mich.	-	-	47,825	47,825	-	-	-	47,825
Total	223,480	125,649	70,169	419,298	48,518	61,856	110,374	529,672
Spruce								
Minn.	197,551	-	-	197,551	-	12,507	12,507	210,058
Wisc.	140,433	27,553	78,768	246,754	37,962	292,759	330,721	577,475
Mich.	7,057	-	39,630	46,687	-	42,853	42,853	89,540
Total	345,041	27,553	118,398	490,992	37,962	348,119	386,081	877,073
Tamarack								
Minn.	9,400	-	-	9,400	-	372	372	9,772
Wisc.	8,296	5,633	387	14,316	-	-	-	14,316
Mich.	-	-	-	-	-	-	-	-
Total	17,696	5,633	387	23,716	-	372	372	24,088
Misc. hdwds.								
Minn.[4/]	5,835	-	-	5,835	-	-	-	5,835
Wisc.[4/]	-	172,122	11,225	183,347	-	-	-	183,347
Mich.[4/]	-	-	44,813	44,813	-	-	-	44,813
Exported[3/]	-	6,000	-	6,000	-	-	-	-
Total	5,835	178,122	56,038	239,995	-	-	-	233,995
All species								
Minn.	672,225	17,233	-	689,458	-	63,532	63,532	752,990
Wisc.	367,516	910,996	553,339	1,831,851	86,480	328,306	414,786	2,246,637
Mich.	9,048	-	426,404	435,452	-	97,068	97,068	532,520
Exported[3/]	-	6,000	429	6,429	-	-	-	-
Total	1,048,789	934,229	980,172	2,963,190	86,480	488,906	575,386	3,532,147

1/ Vertical columns of figures under box heading "Production by states" present the amount of pulpwood cut in each state.

2/ Mostly western states.

3/ Pulpwood shipped to mills outside of region.

4/ Balsam poplar (balm-of-Gilead) in Minnesota; mostly dense hardwoods in other states.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 530

Kiln Cordwood Can Be Seasoned Rapidly Prior to Bucking

Charcoal kiln operators may be able to reduce substantially the seasoning period for kiln cordwood by felling trees in the summer and allowing them to lie until the leaves have dried before bucking them into standard lengths. This is indicated by a small-scale test made in the Upper Peninsula of Michigan in 1957.

Five pairs of sugar maple trees, ranging in diameter from 5 to 9 inches, were cut from a 36-year-old stand of second-growth northern hardwoods. Cutting was done on August 2, 1957. One tree of each pair was felled and left intact. The other five trees were felled and bucked immediately into 4-foot sticks, which were assembled into small piles as is customarily done in preparation for skidding.

At the time of felling an inch-thick disk was cut from the butt end of each stem. The moisture contents of the 10 disks were determined by oven-drying. Analysis showed that there was no significant difference between the average moisture contents of the two groups of trees at the beginning of the test.

The five trees which were not limbed or bucked were allowed to lie until the leaves had withered and had begun to drop off. This took 25 days. On August 27 these trees were also bucked into 4-foot lengths. On the same day wood samples were removed at points 18 inches above the lower end of the butt stick, the middle stick, and the top stick of all 10 trees. The moisture content of each of the 30 samples was determined by oven-drying.

These measurements showed that the sticks from the five trees left lying until the leaves were withered had an average moisture content which was about 13 percent lower than the average for the sticks from trees bucked immediately after felling (fig. 1). This represented a 25-percent decrease in the amount of water present at the time of felling. The latter still needed several months of air-seasoning, while those on which bucking was delayed were all dry enough to carbonize efficiently within a month after felling. This accelerated drying was presumably the result of leaf transpiration which continued for some time after the trees were cut.

April 1958

CHARLES E. BOLDT, Research Forester

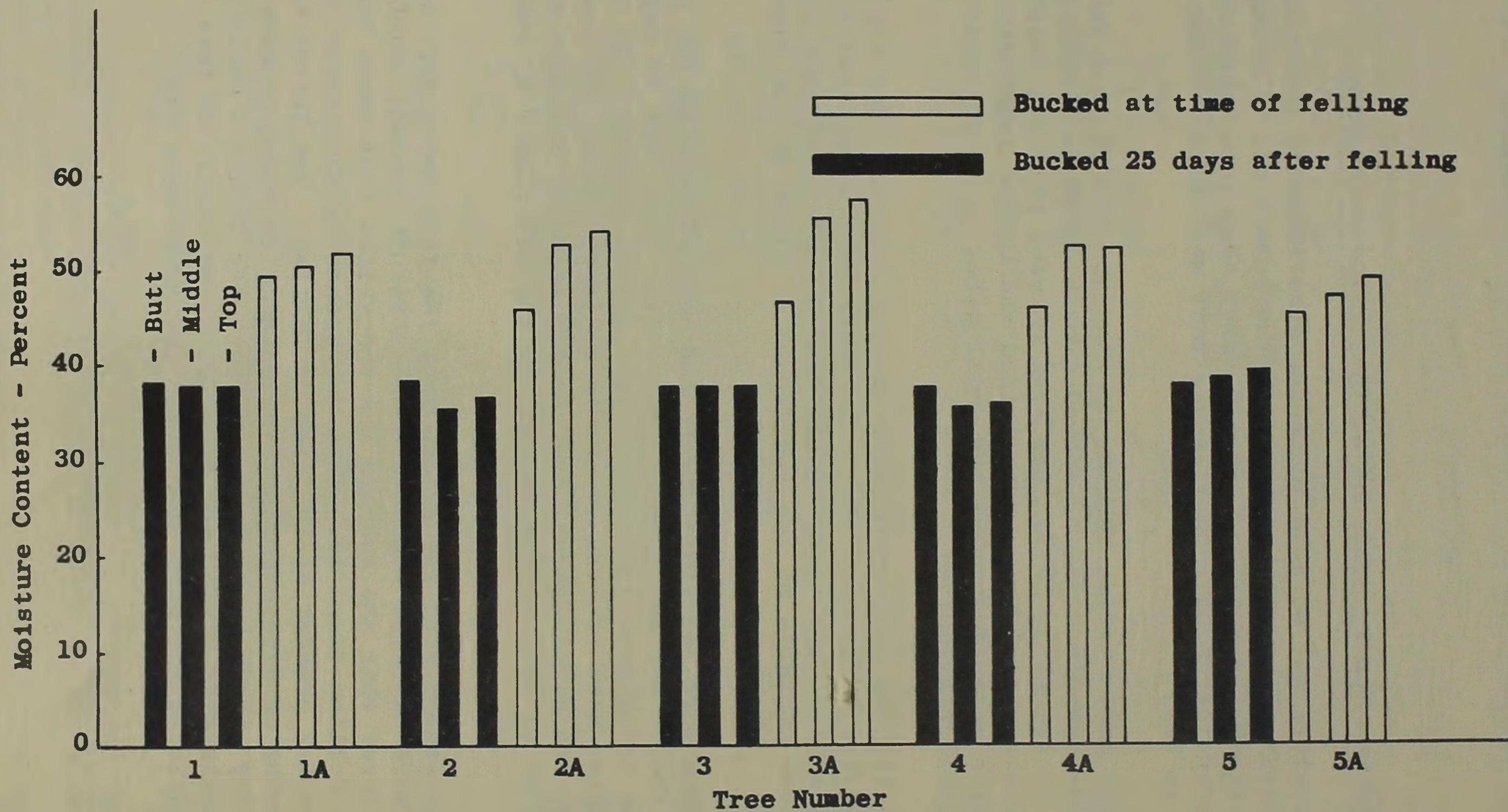


Figure 1.--Moisture content of the butt, middle, and top sticks of 10 sugar maple trees 25 days after felling.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

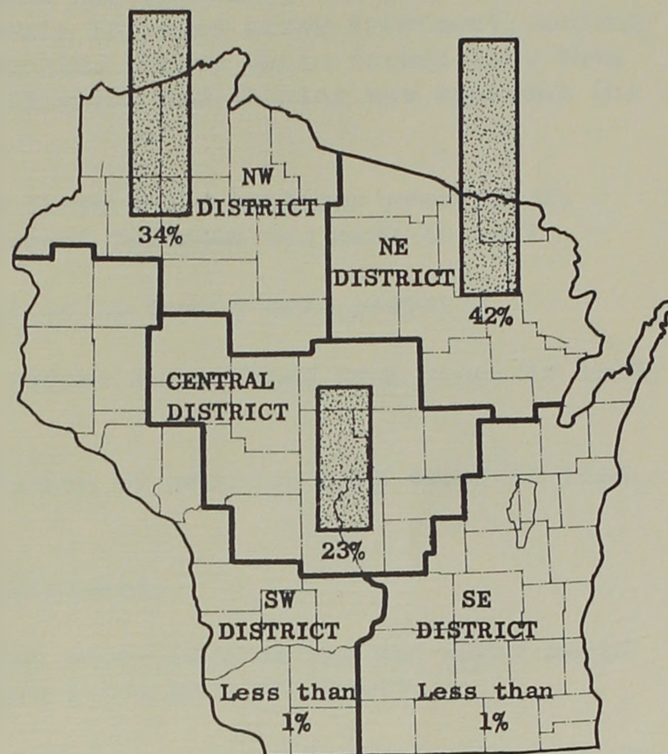
No. 531

Trend of Pulpwood Harvest Up in Wisconsin, Particularly in Central Area

The Northeast District with a cut of 396,000 cords in 1957 was Wisconsin's leading pulpwood producing area; the Northwest District was second with 317,000 cords and the Central District third with 216,000 cords (see table).

Wisconsin's 1957 pulpwood harvest was nearly double that of 1948. An increase in pulpwood cutting was registered in each district to a greater or lesser degree. The largest proportional increase occurred in the Central District where the 1957 cut was 260 percent more than in 1948; the Northeast District was second with a 136-percent increase, and the Northwest third with a 32-percent increase. Only a negligible amount of pulpwood was cut in the Southeast and Southwest Districts 10 years ago, and each still produces less than 1 percent of the total.

The increased use of aspen and dense hardwoods, coupled with the growth to pulpwood size of pine stands (including plantations) near the pulpmills, has resulted in more of the pulpwood being obtained "close to home." This accounts for the stimulated pulpwood cutting in the south half of the State.



Where pulpwood was cut, 1957

Wisconsin pulpwood harvest by district
1948 and 1957

(Thousand standard cords, roughwood basis)

Species	Northeast 1948	Northeast 1957	Northwest 1948	Northwest 1957	Central 1948	Central 1957	SE and SW 1948	SE and SW 1957	State total 1948	State total 1957
Aspen	62	219	90	151	15	82	*	1	167	453
Balsam fir	46	38	39	19	3	3	-	-	88	60
Birch, paper	4	11	3	14	1	1	-	*	8	26
Hemlock	13	14	34	36	4	7	-	-	51	57
Pine	20	23	62	35	35	68	-	-	117	126
Spruce	21	20	12	6	1	2	-	-	34	28
Tamarack	2	3	-	3	1	*	-	-	3	6
Misc. hardwoods	*	68	-	53	-	53	-	4	*	178
All species	168	396	240	317	60	216	*	5	468	934

* Less than 500 cords.

JULY 1958

A. G. HORN, Forest Economist

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 532

Early Thinnings have Increased Forking in a Northern Hardwood Stand

Thinning of a young northern hardwood stand has increased the proportion of forked trees of American elm and sugar maple 19 years after treatment, according to a study made in northeastern Wisconsin. Sugar maple forked less than elm, but a similar relationship between thinning and forking was apparent for both species.

The stand was first cut in 1938 when the 11-year-old saplings averaged 21 feet tall and 2 inches in diameter. A repeat thinning was made in 1947.

Each of the following treatments was applied to four ½-acre plots:

1. All trees were cut within a 2½-foot radius of selected crop trees in 1938, and within a 5-foot radius in 1947.

2. All trees were cut within a 5-foot radius of selected crop trees in 1938, and within a 7-foot radius in 1947.

3. No trees were cut; plots were left unthinned.

That thinning has resulted in an increased percentage of elm and sugar maple crop trees having forks is shown in figure 1 (on back of sheet).

Although the more heavily thinned plots had the greatest board-foot volume in 1957--1,370 board-feet per acre compared to 850 board-feet per acre on the unthinned plots--future volume growth may be limited by the reduction in merchantable length caused by forking. For instance, considering only the crop trees 5 inches in diameter and larger, 42 percent of the sugar maple had forks below 1½ logs on the more heavily thinned plots. This compares with 25 percent on the unthinned plots. The same situation exists in elm; 66 percent of the trees (5 inches d.b.h. and up) forked below 1½ logs on the heavier thinning compared to 46 percent on the unthinned area.

Long-term measurements will be needed to show the effect of forking on quality and quantity timber production, but it is already clear in this experiment that the lighter thinning should be favored for greater clear length for sawlog production. However, results of pruning studies in the same stand[1/] showed that live limbs under 2 inches in diameter, and perhaps larger, can be pruned safely without danger of decay. Therefore, increased production of clear cut logs could result from heavy thinning accompanied by pruning of potential forks.

1/ Skilling, D. D. 1958. Wound healing and defects following northern hardwood pruning. Jour. Forestry 56: 19-22, illus.

July 1958

D. F. CONOVER, Research Forester

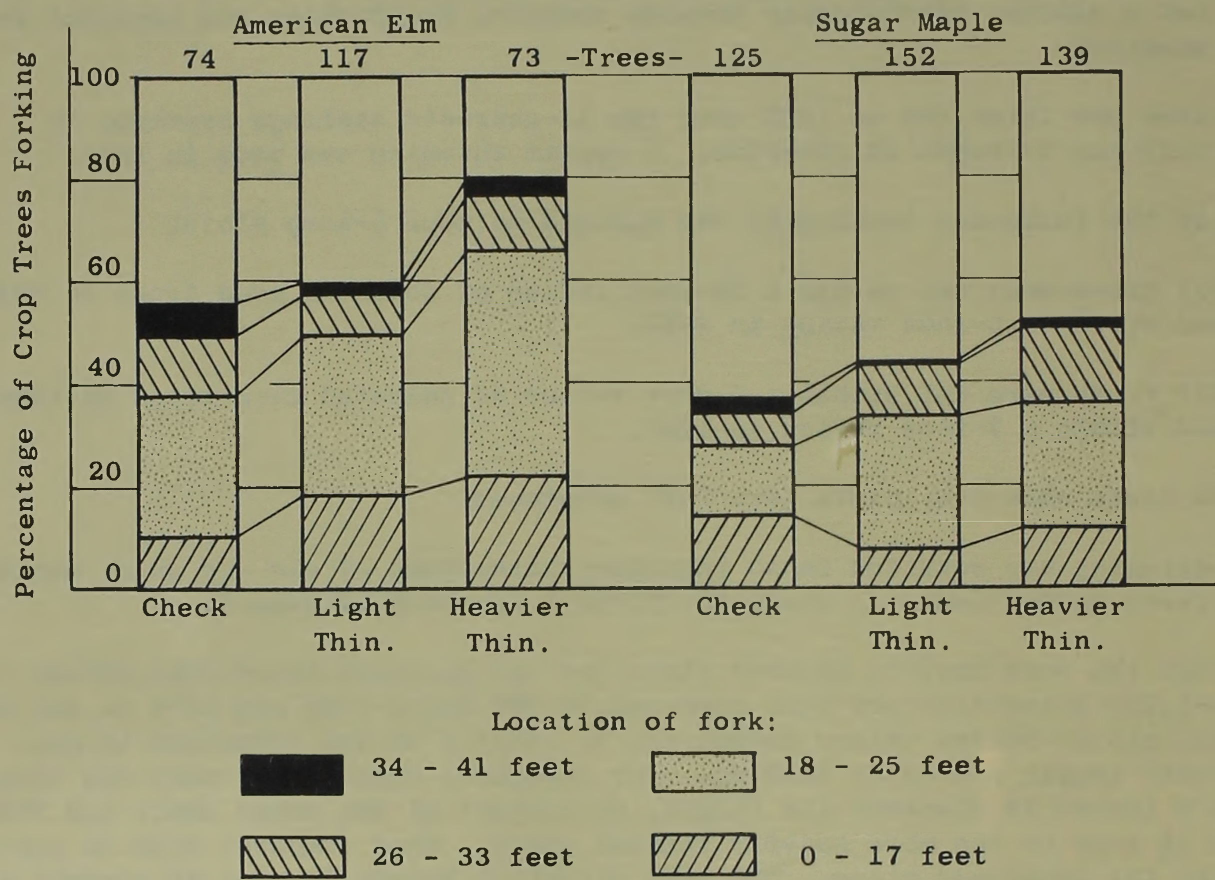


Figure 1.--Percentage of crop trees having forks at various heights in 1957. Trees are 1 inch or more d.b.h.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 533

Effects of Pruning on the Form Growth of a Red Pine Plantation

In May 1934, a study was initiated to determine whether pruning had any effect on tree form in a 20-year-old red pine plantation near Babbitt, Minn. A ½-acre plot was divided into two parts, the trees on one being pruned to 10 feet, about half their total height, and those on the other left unpruned. The trees had been planted at an 8x8-foot spacing in 1917 as 2-1 stock.

The following spring, at age 21, about 50 crop trees were selected on each half of the plot. The diameter of each was measured to the nearest tenth inch at 2, 4½, 8, and 12 feet above the ground, and these points were then marked with narrow bands of white paint to identify them for future remeasurement. Unfortunately, in 1934 several trees on the unpruned part of the plot died, probably as a result of severe drought conditions that year followed by attack by bark beetles (*Ips pini*). The loss of these trees caused a slightly lower density in the unpruned part of the plot.

At age 23 a second pruning was given the treated plot. Two and in some cases three whorls were removed, leaving about 14 feet of clear bole out of a total height of 25 feet. A third pruning at age 30 to a height of 22 to 25 feet removed an average of 6 whorls, 5 of which were living. The trees then averaged 37 feet in height.

The ratio of the diameter at 2, 8, and 12 feet to the diameter at breast height was practically identical in 1935 for both the pruned and unpruned trees (see table). Sixteen growing seasons after pruning, the form ratio at 8 and 12 feet had markedly increased, but the increase was the same for both the pruned and unpruned trees. Apparently the pruning schedule used in this study exerted little or no effect on the form of the trees in their first 12 feet of bole length.

Height above ground (feet)	Form ratio 1/				Diameter (inches)			
	Age 20		Age 36		Age 20		Age 36	
	Pruned trees	Unpruned trees	Pruned trees	Unpruned trees	Pruned trees	Unpruned trees	Pruned trees	Unpruned trees
12	0.61	0.62	0.89	0.89	2.8	2.9	6.5	6.9
8	.83	.83	.93	.95	3.8	3.9	6.8	7.4
4.5	1.00	1.00	1.00	1.00	4.6	4.7	7.3	7.8
2	1.13	1.13	1.08	1.10	5.2	5.3	7.9	8.6

1/ The ratio of the diameter at the indicated height to that at 4.5 feet.
Basis: 51 pruned trees and 48 unpruned trees.

(over)

The unpruned trees grew about a half inch more in diameter at all measurement points than did the pruned trees. In terms of basal area at breast height, the unpruned trees grew 0.035 square foot more than did the pruned trees, a difference of about 17 percent. While some of this increase may be the result of the slightly lower stand density on the unpruned plot, much of it is no doubt due to removal of a substantial part of the live crown during each of three pruning operations. This differential diameter growth is in complete accord with other pruning studies, for example that recently reported for red pine in the Lower Peninsula of Michigan.[1]

R. E. BUCKMAN, Research Forester
E. I. ROE, Forester

1/ Slabaugh, Paul E. Effects of live crown removal on the growth of red pine. Jour. Forestry 55: 904-906, illus. 1957.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION

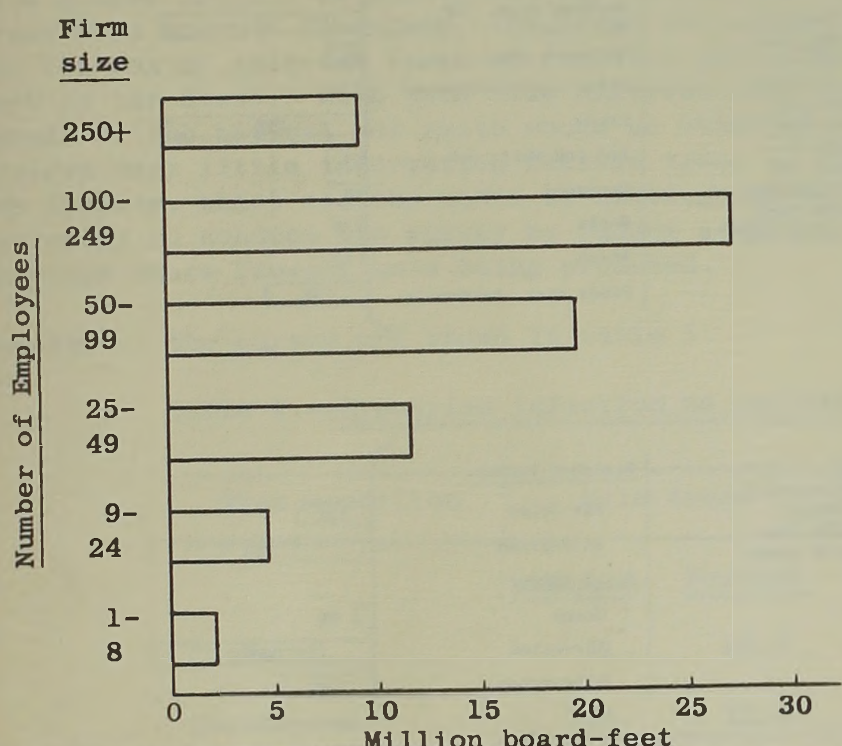
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 534

Lumber Purchases by Seven Manufacturing Industry Groups in Minneapolis and St. Paul, 1956

This note is the last in a series of eight which have reported the results of a pilot research study designed to test the practicality of estimating market data for lumber use by manufacturing firms in the Twin Cities. Seven of 20 manufacturing industry groups were involved. These were lumber and wood, primary metal, fabricated metal, nonelectrical machinery, electrical machinery, transportation equipment, and miscellaneous manufacturing, and totaled to approximately 925 firms.1/ It is estimated that 450 or nearly one-half of these purchased lumber during 1956 for use in their product manufacture, shipping, or storage, or in plant maintenance.

How much lumber do these industries use?--Firms in these groups purchased an estimated 75 million board-feet of lumber during 1956.2/ This overall total apportioned to firm size groups is shown graphically below.



Firm size	Firms in sample	Known firms
250+	45	45
100-249	25	66
50-99	30	81
25-49	48	134
9-24	81	234
1-8	109	327

1/ The divisions used here are those in the Standard Industrial Classification Manual. The data were collected in January 1957 from a random sample of industries taken from the 1955 Minnesota Directory of Manufacturers. Individual firm contacts were made by private forest management Service Foresters of the Division of Forestry, Minnesota Department of Conservation. Technical Notes of this same format have been published for each of the seven manufacturing industry groups and are available on request.

2/ This lumber volume includes purchases of dimension and blocking. Its standard error is ± 13.9 percent--that is, there are 2 chances in 3 that the estimate does not deviate from the true but unknown volume by more than ± 10,400,000 board-feet.

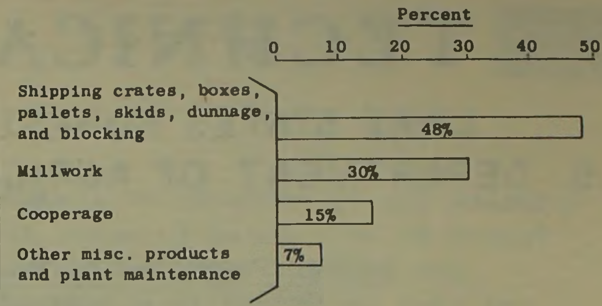
JOHN R. WARNER, Research Forester

JULY 1958

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

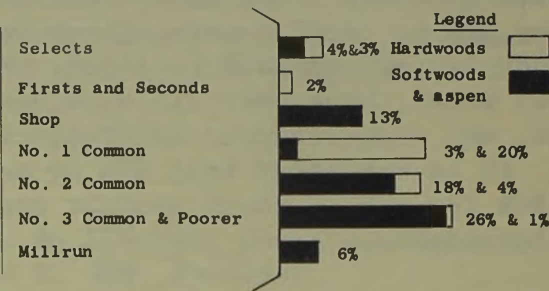
What is the lumber used for?

Packaging, shipping, and storage were the primary uses made of lumber by the majority of manufacturing firms. Companies in the lumber and wood group were responsible for all use in the millwork and cooperage categories. The more important miscellaneous uses of lumber include the manufacture of store fixtures and displays, signs, walk-in refrigerators, caskets, patterns, flasks, bottomboards, and furniture. These accounted for more than 60 percent of this category; less than one-half of 1 percent was used in plant maintenance.



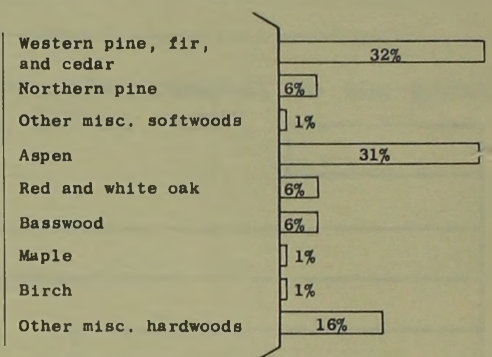
What quality lumber is used?

Many of the interesting and rather distinctive quality requirements of individual manufacturing groups are no longer apparent when these groups are consolidated. Selects, Firsts and Seconds and Shop were in heavy demand for millwork and a large variety of small-volume but medium-to-high quality specialty products. About 75 percent of the No. 1 Common hardwood volume was used by the cooperage industry. The lower grades of Common and the Millrun lumber were used largely for shipping and storage.



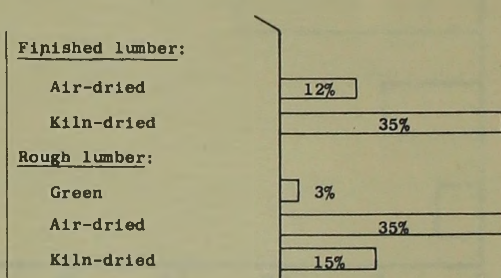
What species are used?

Seventy percent of all reported lumber purchases were softwoods and aspen; the remainder were hardwoods. Most of the aspen and large portions of the basswood and northern pine volume was used for box and crate construction. Sash and door firms were the heaviest users of western pine and fir; shipping was the next most prominent use--about 20 percent of the total. The denser hardwoods were used primarily in product manufacture and secondarily for shipping.



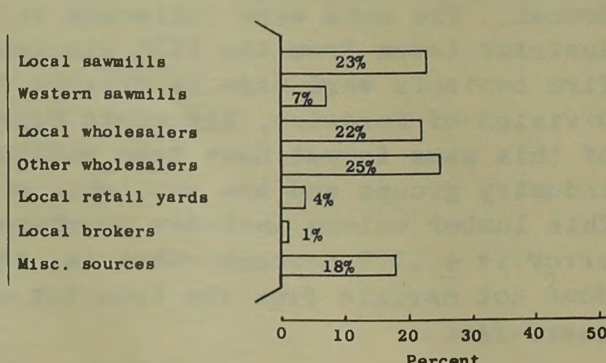
In what form is lumber purchased?

One-half of all lumber purchases reported were kiln-dried, 47 percent air-dried, and 3 percent green. A little more than half of the lumber was purchased in rough form.



Where is it obtained?

The three heavy wood-using industry groups--lumber and wood, nonelectrical machinery, and fabricated metals--were supplied primarily by wholesalers or through direct negotiations with local or out-of-state sawmills. The four remaining groups, using far less lumber, were supplied chiefly through local lumber retail yards and from miscellaneous sources.



TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 535

Hypoxylon Infection Not Greatly Influenced by Sex of Aspen Trees

The results of a survey taken in northern Minnesota indicate that the occurrence of Hypoxylon canker on aspen has little or no correlation with the sex of the tree. This survey was made during the flowering seasons of 1957 and 1958.

This was an exploratory study in that no work has been reported on this phase of the Hypoxylon problem. While a difference in disease resistance between sexes of the same species is unusual, some situations of this type do exist. One example is *Ribes alpinum*, in which the female is susceptible to white pine blister rust and the male is resistant. The survey reported here was made on the chance that such a situation might exist with regard to Hypoxylon canker of aspen.

Because male and female aspen trees do not occur in equal numbers under normal conditions, any sampling confined to infected trees in a localized area might not give a true picture of susceptibility unless the actual ratio of male and female trees were known. Therefore, the first attempt at sampling consisted of determining the sex of infected trees on existing plots located throughout the northern part of the State. With this wide distribution, it was felt that a satisfactory sample of the natural sex ratio would be obtained. This approach, however, yielded very little information because trees in closed stands tended to produce few flowers, which are the means of distinguishing the sexes. Thus it became necessary to conduct the survey by random sampling of diseased and healthy trees in areas where flowers were being produced.

Results of the survey are shown in table 1.

Table 1.--Hypoxylon infection as related to sex in aspen

Tree condition	Male trees		Female trees	
	Number	Percent	Number	Percent
Cankered	71	26.6	72	31.6
Uncankered	196	73.4	156	68.4
Total	267	100.0	228	100.0

While these results showed a somewhat higher level of infection for the female trees, the difference was not excessive; the important thing is that both sexes were commonly found to be infected with the disease.

July 1958

GERALD W. ANDERSON, Research Forester

TECHNICAL NOTES
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 536

Growth and Development of 10 Seed Sources of Scotch Pine in Lower Michigan (15-Year Results)

Scotch pine (*Pinus sylvestris*), one of the first exotic forest tree species planted extensively in the northern United States, often gave poor results after a promising start. Improper seed source has been suspected as a prime cause of the unsatisfactory development. Presently Scotch pine is grown chiefly for Christmas trees in the United States, but it may be useful for wood production under some conditions. It should be of interest, therefore, to compare the growth and survival of stock of 10 known seed sources over a period of 15 years.

The trees were grown from seed supplied by the International Union of Forest Research Organizations as part of an international test. The 2-0 stock was planted in the spring of 1941 on a level area of Grayling sand (a rather poor site) near Wellston, Mich., in the Manistee National Forest. The planting area had been grazed and was generally open. Included were 10 lots of Scotch pine (104 to 462 trees per lot) representing 10 European localities with latitudes 3 to 16 degrees (210 to 1,100 miles) north of the plantation (see table 1 on back of sheet). The localities of origin have about the same length of growing season but lower average temperatures for the period, and only about 70 percent of the annual rainfall.

At the end of 15 growing seasons after planting, survival (ranging from 75 to 87 percent) was excellent. Some early mortality resulted from competition by woody plants, but the principal cause of loss has been the pine root collar weevil (*Hylobius radicis*), and loss from this insect has been increasing. Because of the pattern of infestation little can be deduced as to apparent resistance to this weevil. However, the lot from Mustieki, Lithuania, has suffered very little, while two lots on either side of it have been hit much heavier.

At the end of 15 years, variation between average heights for the various Scotch pine lots was highly significant according to the F test. The trees from seed origins in Finland (Lot 29), Romania (Lot 34), and Norway (Lot 30) are distinctly shorter than those from Poland (Lots 37, 38, 39, and 54), the Netherlands (Lot 33), Lithuania (Lot 53), and White Russia (Lot 55).

Growth has been reduced by several agencies. The white pine weevil (*Pissodes strobi*) had attacked a substantial percentage of trees of all origins by the 15th year. The least affected lots included one from White Russia and two from Poland (Lots 39 and 54) with 46, 56, and 63 percent injury respectively. The lots from the Netherlands and Norway have been most affected (99 and 89 percent). Small amounts of injury occurred in a few lots from oak-pine rust (*Cronartium quercuum*) and sapsucker (*Sphyrapicus varius*) attacks.

On the combined basis of survival, height development, and relative freedom from injury 15 years after planting, three lots from Poland (37, 39, and 54) seem best adapted to this locality. The fact that the poorest source has made only 65 percent the height growth of the best source is one important indication of the value of knowing how stock of different seed origins will perform.

July 1958

PAUL O. RUDOLF, Forester
PAUL E. SLABAUGH, Forester

Table 1.--Seed origin and 15-year planting results of 10 lots of Scotch pine; near Wellston, Michigan

Lot no.	Locality of origin: Name	North latitude	East longitude	15-year results: Survival		Total height: Average		Extremes
				Percent	Rank	Feet	Rank	Feet
54	Rychtal, Poland	51°09'	17°52'	78	5	12.2	1	10.1-14.3
39	Bolewice "A", Poland	52°24'	16°10'	83	2	12.0	2	11.0-14.1
33	Breda, Netherlands	51°34'	4°46'	78	5	11.6	3	9.3-13.5
37	Suprasl "A", Poland	51°13'	23°22'	83	2	10.8	4	7.7-13.6
38	Suprasl "B", Poland	51°13'	23°22'	78	5	10.4	5	6.0-14.2
53	Mustieki, Lithuania1/	54°08'	24°25'	83	2	10.1	6	7.8-12.5
55	Luboml, White Russia1/	51°15'	24°05'	82	3	9.3	7	5.8-12.9
30	Modum, Norway	59°56'	10°01'	87	1	8.1	8	5.0- 9.6
34	Tinocawa, Romania	47°14'	25°18'	75	6	8.0	9	4.4-10.5
29	Bromarv, Finland	59°58'	23°00'	81	4	7.9	10	4.9-10.4
All lots--average or range				81	-	10.0	-	4.4-14.3
P2/	Wellston, Mich.	44°14'	85°57'3/					

1/ At the time of seed collection these localities were included in Poland.

2/ Location of the planting site.

3/ West longitude.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 537

Growth and Development of 12 Seed Sources of Norway Spruce in Lower Michigan (15-Year Results)

Norway spruce (Picea abies) was one of the first exotic forest trees extensively planted in the northern United States. It is grown both to produce long-fibered woodpulp and for Christmas trees. Results in the Lake States generally have been less favorable with Norway spruce, however, than those obtained in the Northeast. One suggestion has been that the best adapted seed sources have not been used. It should be of interest, therefore, to compare the results from planting 12 different seed sources of Norway spruce.

The stock was grown from seed supplied by the International Union of Forest Research Organizations for an international seed source test. The 2-0 trees were planted in the spring of 1941 on a level area of Grayling sand (a rather poor site) near Wellston, Mich., on the Manistee National Forest. The planting area had been grazed and had very little woody cover. Included were 12 lots of Norway spruce (104 to 447 trees per lot) representing 12 European localities with latitudes 2 to 16 degrees (140 to 1,100 miles) north of the planting site (see table 1 on back of sheet). The localities of origin have about the same length of good growing season but slightly lower average temperatures for the period, and only about 70 percent of the annual rainfall (except for the Yugoslavian area with 215 percent).

At the end of 15 growing seasons after planting, survival ranged from 33 percent to 74 percent. The principal causes of mortality have been competition from woody plants and the 1955 drought. During the first year goat browsing, smothering by loose soil, and poor planting caused most of the loss.

Average height growth of trees judged to be reasonably free of surrounding competition ranged from 3.8 feet to 7.3 feet. At the end of 15 years, variation between heights for the several lots was highly significant according to the F tests. One Polish source (Lot 36) has made the best height growth (7.3 feet). The trees from seed origins in Yugoslavia (Lot 28) and Norway (Lot 24) have made the poorest height growth (3.8 and 4.0 feet). The rest of the lots are fairly uniform, averaging 4.8 to 6.0 feet tall.

Height growth has been reduced by the white pine weevil (Pissodes strobi), the summer drought of 1955, a severe late spring frost in 1955, and winter injury. Most prevalent injuries by causes have been as follows: White pine weevil on the lot from Yugoslavia; summer drought in Lot 29 from Romania and Lot 36 from Poland; spring frost damage in Lot 2 from Switzerland, the lot from Norway, and Lot 30 from Romania; and winter injury to the lot from Czechoslovakia, Lot 29 from Romania, the lot from Lithuania, and Lot 35 from Poland.

On the combined basis of survival and height growth one lot from Poland (No. 36) is outstanding. It has a moderate amount of injury, however. If relative freedom from serious injury is taken into account along with good survival and growth, the lots from Pfoerten, Poland (No. 8) and Czechoslovakia (No. 27) rate high. Present results, by no means final, indicate that Norway spruce varies widely in survival, height growth, and injury according to seed origin, and planters should consider seed source very carefully in obtaining stock.

July 1958

PAUL O. RUDOLF, Forester
PAUL E. SLABAUGH, Forester

Table 1.--Seed origin and 15-year planting results of 12 lots of Norway spruce; near Wellston, Michigan

Lot no.	Locality of origin: Name	North latitude	East longitude	15-year results: Survival		Total height: Average		Extremes
				Percent	Rank	Feet	Rank	Feet
36	Dolina, Poland	48°55'	24°00'	74	1	7.3	1	3.6-11.0
34	Bialoweicza, Poland	52°40'	23°45'	58	6	6.0	2	3.1- 8.4
27	Sprinosice, Czechoslovakia	49°40'	16°20'	71	2	3.9	3	2.5- 9.1
8	Pfoerten, Poland[1]	51°45'	14°50'	71	2	5.8	4	2.8- 9.1
35	Radom, Poland	51°25'	21°05'	66	3	5.8	4	2.0- 8.1
1	Alps Mts., Switzerland[2]	47°±	9°±	66	3	5.7	5	4.3- 9.6
30	Valea Bistrei, Romania	46°20'	23°00'	52	8	5.7	5	2.3- 8.0
33	Vilno, Lithuania[3]	54°40'	25°15'	57	7	5.6	6	1.7- 8.4
2	Alps Mts., Switzerland[4]	47°±	9°±	65	4	5.1	7	1.6- 9.1
29	Muntele, Romania	46°20'	25°50'	52	8	4.8	8	2.3- 8.2
24	Hamar, Norway	60°30'	12°10'	33	9	4.0	9	1.4- 6.3
28	Pokljuka, Yugoslavia	46°20'	13°50'	59	5	3.8	10	1.2- 8.9
All lots--average or range				60	-	5.3	-	1.2-11.0
P[5]	Wellston, Mich.	44°16'	85°87'[6]	--	-	--	-	--

1/ At time of seed collection this locality was in Germany.
2/ Elevation 3900-4600 feet above mean sea level.
3/ At time of seed collection this locality was in Poland.
4/ Elevation 4600-4900 feet above mean sea level.
5/ Location of planting site.
6/ West longitude.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 538

Effect of Gibberellic Acid on Forcing Hardwood Cuttings for Pollen Collection

It is often advantageous to collect pollen prior to the natural shedding dates by forcing flower-bearing cuttings in the greenhouse. The results of an exploratory study carried out at the Northern Institute of Forest Genetics, Rhinelander, Wis., indicate that gibberellic acid may be useful in promoting more rapid development of the flowers on cut branches.

On Jan. 10, 1958, short flower-bearing cuttings 6 to 12 inches long were collected from trees of five species: *Acer rubrum* (red maple), *Betula papyrifera* (paper birch), *Populus grandidentata* (bigtooth aspen), *P. tremuloides* (quaking aspen), and *Prunus pensylvanica* (pin cherry). Concentrations of gibberellic acid of ¼ percent and 1 percent by weight in lanolin were applied to terminal wounds on the cuttings; plain lanolin was applied to the controls. The cuttings were placed in tap water and maintained under ordinary greenhouse conditions--72° F. day temperature, and 62° night temperature.

In all species, both vegetative and floral buds broke dormancy earlier and developed more rapidly on the gibberellic acid-treated cuttings than on the controls. No differences of practical importance were noted between the two concentrations of gibberellic acid.

The results, in terms of the first date of pollen shed, varied by species and treatment (table 1). Pollen shed from the gibberellic acid-treated cuttings of *Acer*, *Betula*, and *Prunus* began 9, 16, and 9 days, respectively, prior to their controls. All the *Populus* cuttings, however, began shedding pollen on the same date, although the gibberellic acid-treated cuttings of both species broke dormancy several days in advance of the controls. This lack of treatment effect was probably due to a longer growth period prior to pollen shed on the treated cuttings which resulted in catkins about three times longer than those of the control cuttings. A similar elongation phenomenon was noted in *Acer rubrum* where the flower stamens on cuttings treated with gibberellic acid averaged about 3 centimeters in length as contrasted to 0.5 centimeter for the controls.

Pollen yield was good from *Acer* and *Prunus*, but was relatively low from *Betula* and both species of *Populus* for all treatments including the control. This low pollen yield undoubtedly was due to the unfavorable forcing conditions prevailing in the greenhouse during the test. Although the *Populus* flowers elongated rapidly, most abscised just prior to pollen shed.

The results of this preliminary study indicate that gibberellic acid may be useful in shortening the forcing period of flowers collected for pollen extraction. Further tests are required to determine the best methods of application, optimum forcing conditions, and the effect of treatment on pollen viability.

July 1958

PHILIP R. LARSON, Physiologist

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--Date of first pollen shed

Species	Treatment1/	Days after treatment					
		7	12	17	21	26	33
Acer rubrum	C				x		
	GA ¼ percent		x				
	GA 1 percent		x				
Betula papyrifera	C						x
	GA ¼ percent			x			
	GA 1 percent			x			
Populus grandidentata	C	x					
	GA ¼ percent	x					
	GA 1 percent	x					
Populus tremuloides	C	x					
	GA ¼ percent	x					
	GA 1 percent	x					
Prunus pensylvanica	C					x	
	GA ¼ percent			x			
	GA 1 percent			x			

1/ C = control; GA = gibberellic acid.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 539

FOREST PLANTING TRENDS IN NORTHERN LOWER MICHIGAN

Forest plantings have covered two-thirds of a million acres in the North half of Lower Michigan during the last 50 years. Acreages planted are about evenly divided among national forest, state forest, and private lands. Early plantings were nearly all on public lands but in recent years private plantings have exceeded public acreages planted.

The data presented below are preliminary summaries from a survey recently completed by the Lake States Station, the Lower Michigan National Forest, the Michigan Department of Conservation, and the Consumers Power Company (see map of study area).

From 1900 to 1920 less than 8,000 acres were planted in the study area. This was increased by more than 71,000 acres during the twenties (see fig. 1). Tree planting sky-rocketed in the thirties as depression-born work programs sent thousands of men into tree planting projects; nearly 275,000 acres were planted, all but 7 percent publicly owned. During the forties, because of the diversion of men and materials to the war effort, only 70,000 acres were planted on public lands, primarily after the war. Overall planting on public forests from 1950 to 1956 stabilized at the 1940 to 1949 level, with a small decline on national-forest land offset by an increase on state forests. Private plantings, on the other hand, increased very rapidly in the late forties as the use of tree planting machines became widespread and during the early fifties was nearly four times larger than the annual rate of the previous decade. Three-fourths of all planting from 1950 to 1956 occurred on private lands.

Table 1 presents the planting totals by species group and decade for the three owner classes. On the national forests more than one-half of the trees planted were red pine in pure stands, while on state forests 60 percent of the plantings were a mixture of red and jack pine. Less than one-half of one percent of all public plantings were spruce. About half of the plantings on private lands are red pine and one-fifth are scotch pine.

While the 660,600 acres reforested is impressive, much forest land still is nonstocked or understocked, and must be planted if full timber production in the area is desired. Over 1.4 million acres of forest land and considerable sub-marginal farm land should be reforested. Also, the figures given here are for "acres planted", not "acres of successful plantations." Estimates of the latter will be given in another note. At the present rate of planting it will take half to three-quarters of a century to restock Northern Lower Michigan's once great "Pinery."

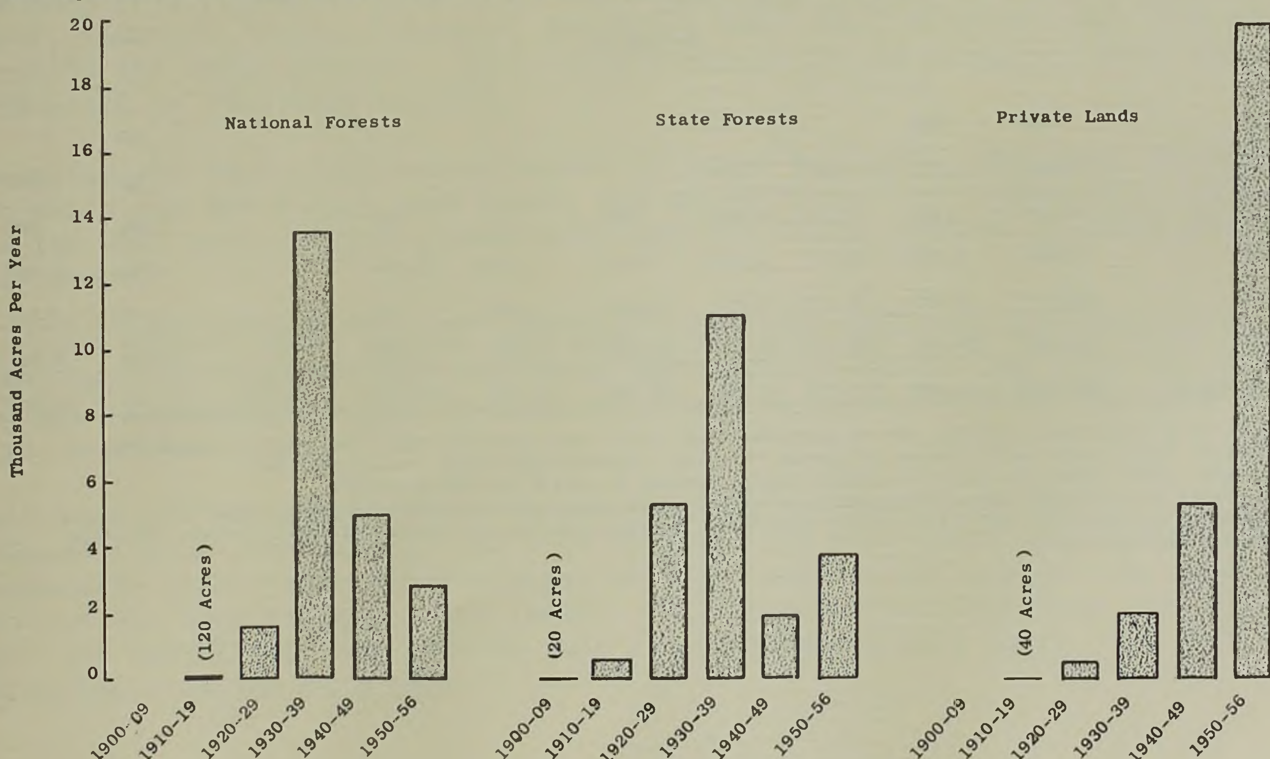


Figure 1.--Planting trends in Northern Lower Michigan by owner, 1900-1956.

JULY 1958

ROBERT N. STONE, Forester

Table 1.--Forest plantings in Northern Lower Michigan by owner, species group, and decade.

(In acres)

Years	Totals	White pine	Red pine	Jack pine	Scotch pine	White & red pine	Red & jack pine	White, red, & jack pine	Spruce	Misc. 1/ Conifers
					National Forest					
1910-19	1,240	60	960	-	10	120	-	-	-	90
1920-29	13,270	240	13,030	-	-	-	-	-	-	-
1930-39	143,380	9,040	79,690	18,450	300	10,220	24,460	-	1,200	20
1940-49	50,320	1,660	17,320	14,210	30	7,110	9,920	-	60	10
1950-56	20,400	1,130	16,570	410	-	460	1,790	-	40	-
Total	228,610	12,130	127,570	33,070	340	17,910	36,170	-	1,300	120
					State Forest 2/					
1906-09	240	100	30	-	110	-	-	-	-	-
1910-19	5,620	1,560	530	430	30	80	1,040	-	350	1,600
1920-29	53,350	13,660	40	5,670	-	-	30,990	1,800	-	1,190
1930-39	110,910	370	1,950	80	-	12,090	78,130	17,260	-	1,030
1940-49	19,280	-	280	10	-	-	17,390	1,420	180	-
1950-56	26,180	1,740	13,570	8,270	-	60	2,490	40	10	-
Total	215,580	17,430	16,400	14,460	140	12,230	130,040	20,520	540	3,820
					Private 3/					
1909	-	-	-	-	-	-	-	-	-	-
1910-19	400	200	-	-	-	-	-	-	200	-
1920-29	4,500	1,800	1,400	500	-	-	-	-	700	100
1930-39	20,000	5,200	9,000	2,900	600	-	500	-	1,600	200
1940-49	52,800	9,300	24,500	5,500	5,300	200	1,000	-	4,700	2,300
1950-56	138,700	9,000	71,400	5,600	40,200	1,600	500	-	5,000	5,400
Total	216,400	25,500	106,300	14,500	46,100	1,800	2,000	-	12,200	8,000
All Ownerships	660,590	55,060	250,270	62,030	46,580	31,940	168,210	20,520	14,040	11,940

1/ Includes miscellaneous conifers such as ponderosa pine, pitch pine, Austrian pine, Douglas-fir, balsam fir, European larch, and a small acreage of unusual mixtures. Hardwood plantings are not included.

2/ Excludes state forest plantings in Allegan County, records for which are not available.

3/ Estimated from shipment summaries of public nurseries on the basis of one thousand trees per acre. Shipments of fewer than 500 trees are not included. Includes plantings on county and school forests and other small public holdings.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 540

1957 Forest Tree Seed Crop about Average in the Lake States

During 1957 overall forest tree seed crops in the Lake States were about average for the 12-year period since 1946, according to observations made at field centers of the Lake States Forest Experiment Station. Outstanding were the bumper or near-bumper crops of red pine and white pine cones throughout the region (see table on reverse side). This contrasts with 1956 when these two species were the poorest of all reported. Seed crops of other tree species generally varied by localities from poor to good.

In northern Minnesota bumper crops were reported in some localities for red pine, white pine, basswood, yellow birch, and paper birch. Seed crop failures occurred among the following species: White spruce, black spruce, northern white-cedar, and tamarack.

In northeastern Wisconsin red pine had the only bumper crop, but good seed crops were produced by white pine, paper birch, quaking aspen, and bigtooth aspen. Crop failures were reported for the spruces and sugar maple. Other species had poor to fair crops.

The only species with a bumper seed crop in central Upper Michigan was white pine. Good crops, however, were borne by red pine, yellow birch, and red oak. The seed crop failed in jack pine, white spruce, balsam fir, northern white-cedar, tamarack, beech, basswood, and black ash. Poor to fair crops were produced by the other species. This is in contrast to the generally good seed production in this area in 1956.

Generally the best crops were produced in Lower Michigan. Red pine, white pine, and white oak had bumper seed crops, and white spruce had a good crop. Beech was the only species with a seed crop failure. Other species produced poor to fair crops.

In north central North Dakota good seed crops were reported for American elm, green ash, chokecherry, American plum, and Russian-olive. The only crop failure was in ponderosa pine. Poor to fair crops were produced by all other species reported.

Most seed collectors are interested chiefly in the pines, so 1957 will be considered a good seed year in the Lake States. Red pine produced the best crop regionally since these reports began in 1946, and the white pine crop equalled that of the best previous year (1946). Wildlife species depending largely on mast for winter food had good to fair prospects where oaks occur, but poor ones where beech is the main food.

October 1958

PAUL O. RUDOLF, Forester

Table 1.--Forest tree seed crops in the Lake States, 1957

Species	Estimated percentage of a full crop[1/] in--				
	Northern Minnesota	Northeastern Wisconsin	Central Upper Michigan	Lower Peninsula Michigan	North central North Dakota
Red pine	75-95	95	75	2/95	3/-
Eastern white pine	95	75	95	2/95	-
Jack pine	25-75	25	7	-	-
Scotch pine	-	25	-	-	-
Ponderosa pine	-	-	-	-	7
White spruce	7-75	7	7	75	-
Black spruce	7-50	7	25	-	-
Norway spruce	-	7	-	-	-
Balsam fir	25-50	25	7	-	-
Eastern hemlock	-	-	25	-	-
Northern white-cedar	7-75	50	7	-	-
Tamarack	7-25	50	7	-	-
Sugar maple	75	7	25	4/50	-
Red maple	-	-	25	-	-
Boxelder	-	-	-	-	25
American beech	-	-	7	7	-
Basswood	95	25	7	-	-
Yellow birch	95	50	75	-	-
Paper birch	50-95	75	25	-	-
Quaking aspen	25	75	50	-	-
Bigtooth aspen	-	75	50	-	-
American elm	50	-	25	4/50	75
Siberian elm	-	-	-	-	50
Hackberry	-	-	-	-	25
White ash	-	25	-	-	-
Green ash	-	-	-	-	75
Black ash	25	25	7	-	-
Bur oak	-	-	-	-	50
Northern pin oak	-	-	-	50	-
Black oak	-	-	-	25	-
Northern red oak	-	5/50	75	25	-
White oak	-	-	-	95	-
Chokecherry	-	-	-	-	75
American plum	-	-	-	-	75
Russian-olive	-	-	-	-	75
Caragana	-	-	-	-	50

1/ Percentages of a full crop are classified as 0-15, failure; 16-35, poor; 36-60, fair; 61-90, good; and 91-100, bumper.
2/ Indicates north half of Lower Peninsula.
3/ - signifies no report on this species.
4/ Indicates south half of Lower Peninsula.
5/ Southern Wisconsin.

TECHNICAL NOTES

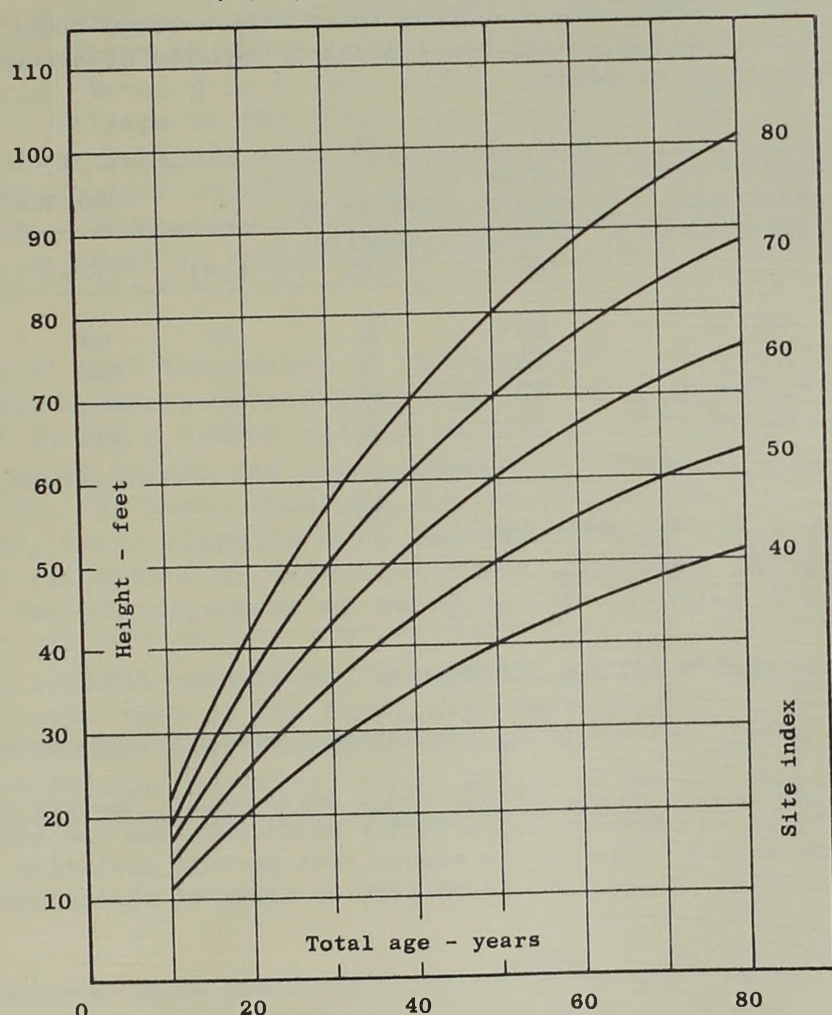
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 541

Site Index Curves for Paper Birch in Northern Wisconsin

The site index graph for paper birch, Betula papyrifera, shown below is based on measurements taken on 104 plots in northern Wisconsin and 4 plots in the Upper Peninsula of Michigan.1/ The average age of dominant and codominant trees on these plots ranged from 17 years to 96 years, and site index at 50 years ranged from 34 feet to 77 feet. A statement on site index use and limitation is on the reverse side.

PAPER BIRCH
IN NORTHERN WISCONSIN



1/ The study was conducted in part with funds contributed by several forest industries through the Lake States Council of Industrial Foresters.

October 1958

JOHN H. COOLEY, Research Forester

Site Index--Its Use and Limitations[2/]

Site index is the height attainable by the average dominant and codominant trees in relatively pure, even-aged, and well-stocked stands at the age of 50 years. It reflects the combined effect of different environmental factors and is used as a measure of stand productivity.

To evaluate site index, a number of sample trees in a stand should be measured for total height and age. Only dominant and codominant trees should be used. These trees are part of the main canopy or extend above it, receiving full light from above but comparatively little from the sides. A good rule-of-thumb for an adequate sample of height measurements or age borings is

$$n = 5 + \frac{R^2}{30}$$

where R = observed range of total heights or ages in the stand. The selection of these sample trees should be made in some systematic manner, covering the range of diameter classes to insure a representative sample. The curves for paper birch recognize total age rather than age at breast height.

After the sample tree measurements have been taken, the average total height and the average age should be computed, using basal areas or squares of diameters as weights. A sample calculation is given below:

D.b.h. (Inches) (d)	Dominant and codominant heights (feet)	Average height (feet) (h)	Number of samples (n)	Computations			
				(d^2)	(nd^2)	(w)[1/]	(wh)
7	48, 52	50	2	49	98	1.0	50
8	52, 55, 58	55	3	64	192	2.0	110
9	56, 57, 58	57	3	81	243	2.5	142
10	58, 60	59	2	100	200	2.0	118
Sum			10			7.5	420

Average height $= \frac{420}{7.5} = 56$

1/ Relative weights (w) are based on $nd^2 = 100 = 1.0$.

In estimating site index, the following limitations should be considered:

1. The index will not apply to any stands whose development, because of climatic or soil peculiarities, is expected to be widely different from the average trend portrayed by the curves. The curves assume that percent deviation of observed height above or below the central trend remains constant throughout the life of the stand.

2. The site index cannot be properly evaluated in stands where dominant and codominant trees have been affected by past suppression.

3. The curves should not be applied to extremely dense or very open stands where stagnation or excessive crown development is observed.

2/ From Gevorkiantz, S. R. Site index curves for aspen in the Lake States. U. S. Forest Serv., Lake States Forest Expt. Sta. Tech. Note 464, 2 pp., illus. 1956.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 542

Timing DDT Sprays in the Spring for European Pine Shoot Moth Control

Life history studies of the European pine shoot moth by Miller and Neiswander[1/] have shown that in the spring the insect moves out of infested buds and seeks new buds to feed in. A DDT spray applied during this spring movement gave control as good as was obtained with a similar spray applied in the summer when the newly hatched larvae were exposed. Since these first tests were made, other investigators have tried spring treatment with similar success. This Technical Note discusses briefly the results of some studies which were designed to show the full extent of time available for spring spraying.

Timing tests with DDT sprays were carried out in Lower Michigan in the spring of 1957 over a 6-week period and repeated in 1958 over a 9-week period. Several concentrations of DDT were applied by means of back-pack sprayers to infested red pine trees 3 to 6 feet tall. Treatments were applied at 12-day intervals. The foliage of the trees was well moistened. In 1957, plots consisted of 50 trees each and were located in Ottawa and Wexford Counties; in 1958, they consisted of roughly 25 trees each and were located in Ottawa and Ingham Counties. Treatments were evaluated by counting infested and non-infested tips on about 25 sample trees during June when the surviving insects were pupating.

The tests showed that the number of infested tips on red pine were reduced 90 percent or more by sprays containing 2 pounds of actual DDT per 100 gallons of water applied during a 4-week optimum period in the spring. This period included the 2 weeks before and the 2 weeks after the beginning of external larval activity. In Lower Michigan, it coincided with the month of April; it can, of course, shift slightly with abnormal weather which might speed up or slow down the resumption of larval activity. Doubling the concentration of DDT extended the effectiveness of the spray about a week.

For practical control operations, the surest method of properly timing spring sprays is to apply them at the first sign of new larval feeding. New feeding appears as glistening resin exudates around the buds. If no observations are made on larval feeding activity, trees can be sprayed about April 15 in the latitude of Lower Michigan with reasonable assurance of success.

WILLIAM E. MILLER, Entomologist[2/]
DEAN L. HAYNES, Entomologist[2/]

October 1958

1/ Miller, W. E. and R. B. Neiswander, 1955. The biology and control of the European pine shoot moth. Ohio Agric. Exper. Sta. Res. Bull. 760: 1-31.

2/ Stationed at East Lansing, Mich., in cooperation with Michigan State University.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 543

Control of the European Pine Shoot Moth with Concentrated DDT Sprays

In an effort to reduce the large gallonages of water used in hydraulic sprays for European pine shoot moth control, concentrated sprays applied by mist blower were tested during the spring and summer of 1956, the summer of 1957, and the spring of 1958 in Ottawa County, Lower Michigan. The good control obtained with volumes of less than 50 gallons of spray per acre makes concentrate spraying a promising method.

The test treatments were applied to replicated ½- or 1-acre plots of red pine trees mostly from 4 to 6 feet tall. Applications were made at two different times: in late June when newly hatched larvae were just beginning to feed and in the middle of April when partly grown larvae were just resuming their feeding after hibernation. Several mixtures were tried ranging from 2½- to 12-percent DDT at rates of from 5 to 40 gallons of spray per acre. Evaluations were made later by comparing the numbers of insects on the treated plots with those on nearby untreated plots.

Mist blowers generate a high-velocity blast of air to carry the spray, thereby making it possible to reduce the quantity of liquid in the spray mixture. The more effective of the two mist blower models used in these tests moved 28,000 cubic feet of air per minute at a velocity of 100 miles per hour. It discharged spray from a single jet in the center of the airstream, and is a type widely used in shade tree protection work. However, this machine had to be moved over each test area from 2 to 4 times at the slowest tractor speeds to attain the rate of application shown by this study to be best. This model would therefore not have practical value in shoot moth control work. However, mist blowers with higher spray outputs and higher air volume movements are available and should be used in field operations. One such model, shown in the figure on the back, was used during an actual control operation on the Lower Michigan National Forest.

The least DDT concentration and liquid spray volume required to reduce populations 90 percent or more in both the summer and spring tests was 2½-percent DDT at 40 gallons of spray per acre. On one plot with smaller than average trees, similar results were obtained with a lower volume of spray. Satisfactory coverage of the experimental areas by a hydraulic sprayer would have required between 300 and 500 gallons of spray per acre. The concentrated mist-blower spray therefore accomplished practically the same result with roughly one-tenth the spray volume. An added advantage was that 5 rows of trees spaced at 6x6 feet were treated at one time.

Suggested mist-blower spray mixtures and application rates based on these experiments are as follows: trees 4 to 6 feet tall--50 gallons per acre mixed at the rate of 1 gallon of 25-percent emulsifiable DDT concentrate per 9 gallons of water; trees less than 4 feet tall--35 gallons per acre of the same mixture. Spraying should not be attempted at wind velocities of more than 7 miles per hour. Also, excessive brush should be removed for best results.

The timing for concentrated mist-blower sprays in Lower Michigan is the same as for hydraulic sprays: spring applications at first external evidence of larval activity (about mid-April); summer applications when the new larvae begin hatching (late June or early July).

William E. Miller, Entomologist[1/]
Dean L. Haynes, Entomologist[1/]

October 1958

1/ Stationed at East Lansing, Michigan, in cooperation with Michigan State University.

This type of mist blower was successfully used in control operations in 1958 in Lower Michigan.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 544

FOREST PLANTINGS IN NORTHERN LOWER MICHIGAN BY COUNTY

During the last 50 years two-thirds of a million acres have been planted to trees in 34 counties in northern Lower Michigan. Six of these counties have each had more than 30,000 acres planted; only nine have had less than 10,000 acres each.

These estimates were derived from a survey recently completed by the Lake States Forest Experiment Station, the Lower Michigan National Forest, the Michigan Department of Conservation, and the Consumers Power Company. One already published report, Technical Note No. 539, showed planting trends by decades. In that Note, as in this one, the figures given are for "acres planted," not "acres of successful plantations." Estimates of the latter will be given in a subsequent report.

Although forest plantings vary widely by counties, some patterns are apparent (fig. 1). Counties with high public ownership of forest land tend to have large plantation areas (table 1). Where soils are relatively productive for general farming as in Mecosta, Midland, and Arenac Counties, the area planted is below average. Generally, planting on private lands declines across the survey area from southwest to northeast.

Ottawa County has the largest acreage of private plantings; it is closely followed by Muskegon County. This is due to an expanding Christmas tree industry in the area. The major emphasis is on Scotch pine, preferred for Christmas trees.

The most extensively planted single species is red pine, accounting for 250,000 acres. Next in importance is red and jack pine, which are often planted in mixtures on public lands; this combination covers a quarter of the area planted. Although eastern white pine has decreased in popularity because of the twin hazards of blister rust and weevil damage, it still ranks as the third most important species. A phenomenal rise in the rate of planting Scotch pine has occurred during the last decade, almost entirely on private lands.

The major planting effort is now concentrated in the western part of the survey area. The six counties with the highest planting rates during the early fifties in order of importance are Wexford, Ottawa, Benzie, Newaygo, Missaukee, and Grand Traverse Counties.

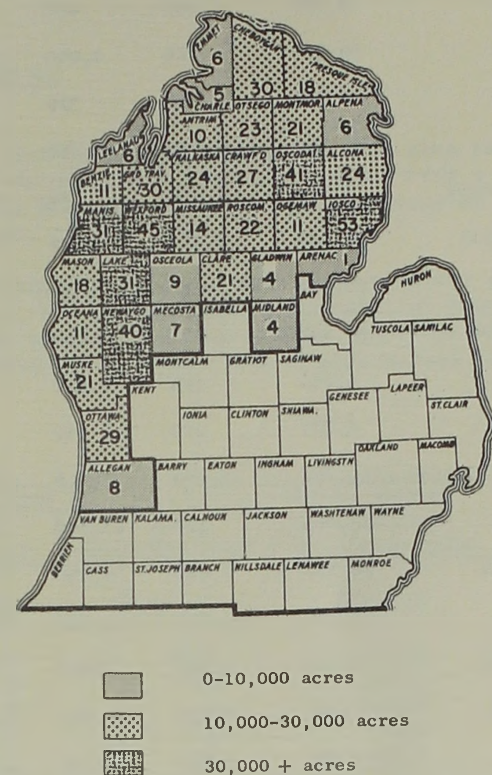


Figure 1.--Forest plantings by county, 1900-56. The figures within each county indicate total area planted in thousands of acres.

Table 1.--Forest plantings in northern Lower Michigan by county and owner, 1900-56

(In acres)

County	Total	National forest	State forest	Private 1/	County	Total	National forest	State forest	Private 1/
Alcona	23,540	20,640	-	2,900	Mason	17,480	10,680	-	6,800
Allegan	7,800	-	2/	7,800	Mecosta	6,870	950	20	5,900
Alpena	5,990	-	4,790	1,200	Midland	4,030	-	30	4,000
Antrim	10,230	-	1,830	8,400	Missaukee	13,720	-	4,520	9,200
Arenac	1,340	-	440	900	Montmorency	21,000	-	19,200	1,800
Benzie	11,320	-	3,220	8,100	Muskegon	20,810	310	-	20,500
Charlevoix	5,160	-	2,460	2,700	Newaygo	40,490	29,290	-	11,200
Cheboygan	29,470	-	22,670	6,800	Oceana	11,200	5,800	-	5,400
Clare	20,720	-	16,720	4,000	Ogemaw	11,050	-	9,750	1,300
Crawford	26,890	4,650	21,040	1,200	Osceola	9,180	-	80	9,100
Emmet	5,560	-	2,960	2,600	Oscoda	41,460	33,110	5,750	2,600
Gladwin	4,420	-	2,420	2,000	Otsego	22,580	-	14,580	8,000
Grand Traverse	29,760	-	18,760	11,000	Ottawa	28,700	-	-	28,700
Iosco	53,190	51,680	10	1,500	Presque Isle	17,770	-	16,270	1,500
Kalkaska	24,120	-	18,620	5,500	Roscommon	22,010	-	21,610	400
Lake	31,290	28,790	800	1,700	Wexford	45,360	24,130	5,030	16,200
Leelanau	5,540	-	540	5,000					
Manistee	30,540	18,580	1,460	10,500	Total	660,590	228,610	215,580	216,400

1/ Estimated from shipment summaries of public nurseries on the basis of one thousand trees per acre. Shipments of fewer than 500 trees are not included. Includes plantings on county and school forests and other small public holdings.

2/ Excludes state forest plantings in Allegan County, for which records are not available.

ROBERT N. STONE, Forester

OCTOBER 1958

MINNESOTA IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 2.--Forest plantings in northern Lower Michigan by county and species group, 1900-56

(In acres)

County	Totals	White pine	Red pine	Jack pine	Scotch pine	White & red pine	Red & jack pine	White, red, & jack pine	Spruce	Misc. 1/ conifers
Alcona	23,540	650	12,600	3,000	300	280	6,530	-	160	20
Allegan	2/ 7,800	950	2,110	830	2,490	10	-	-	990	420
Alpena	5,990	1,700	460	110	260	1,120	1,670	30	250	390
Antrim	10,230	900	4,050	1,340	3,020	-	320	-	340	260
Arenac	1,340	50	780	300	130	-	-	-	50	30
Benzie	11,320	1,210	5,760	1,860	1,630	-	390	-	290	180
Charlevoix	5,160	1,600	1,570	700	100	40	590	320	160	80
Cheboygan	29,470	3,500	4,990	500	570	1,510	12,240	4,910	240	1,010
Clare	20,720	530	2,820	80	770	-	16,070	80	270	100
Crawford	26,890	1,950	4,060	2,440	290	1,540	14,850	970	80	710
Emmet	5,560	400	3,070	200	350	30	650	560	150	150
Gladwin	4,420	230	1,060	490	100	-	700	1,460	350	30
Grand Traverse	29,760	3,680	7,310	2,410	1,230	2,280	9,530	2,250	890	180
Iosco	53,190	620	43,280	2,850	540	1,060	4,330	-	370	140
Kalkaska	24,120	1,080	5,350	1,150	790	340	10,980	4,200	160	70
Lake	31,290	2,360	11,850	6,110	90	3,940	6,800	-	80	60
Leelanau	5,540	1,020	3,030	390	610	-	160	-	240	90
Manistee	30,540	3,640	12,060	5,860	1,310	3,880	3,210	-	290	290
Mason	17,480	1,080	7,100	2,460	1,760	1,680	2,880	-	300	220
Mecosta	6,870	940	3,410	250	1,010	190	270	-	530	270
Midland	4,030	880	1,580	780	450	-	10	-	200	130
Missaukee	13,720	280	7,460	1,550	1,350	-	1,820	390	740	130
Montmorency	21,000	960	1,940	1,740	360	990	14,460	350	140	60
Muskegon	20,810	3,640	7,760	670	6,040	-	-	-	1,470	1,230
Newaygo	40,490	5,230	15,350	3,190	2,650	5,210	7,450	-	370	1,040
Oceana	11,200	1,950	6,380	970	560	400	20	-	550	370
Ogemaw	11,050	1,290	850	600	170	450	6,500	650	100	440
Osceola	9,180	500	6,050	520	1,530	-	-	-	250	330
Oscoda	41,460	1,270	24,710	7,250	180	610	6,510	190	720	20
Otsego	22,580	1,970	7,000	1,150	1,360	2,580	7,710	520	170	120
Ottawa	28,700	3,540	7,500	2,190	11,830	-	-	-	1,970	1,670
Presque Isle	17,770	740	850	350	570	1,090	13,220	440	170	340
Roscommon	22,010	3,860	440	1,020	90	1,020	11,450	2,970	80	1,080
Wexford	45,360	860	25,680	6,720	2,090	1,690	6,890	230	920	280
Total	660,590	55,060	250,270	62,030	46,580	31,940	168,210	20,520	14,040	11,940

1/ Includes miscellaneous conifers such as ponderosa pine, pitch pine, Austrian pine, Douglas-fir, balsam fir, European larch, and a small acreage of unusual mixtures. Hardwood plantings are not included.

2/ Excludes state forest plantings in Allegan County, for which records are not available.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 545

FOREST AREA IN MICHIGAN COUNTIES

The forests of Michigan in 1955 totaled 19.7 million acres. All but 600,000 acres of this area is commercial forest land capable of producing usable crops of wood. By county, forest area ranges from a low of 32,700 acres in Clinton County to a high of 1,125,100 acres in Marquette County. Only 4 counties are less than 10 percent forested; 11 are over 90 percent forested.

Forest area and other forest resource information are the product of a cooperative Forest Survey conducted by the Forest Service, U. S. Department of Agriculture, and the Michigan Department of Conservation with participation by forest industries and other public agencies in some areas. Additional information pertaining to the forest resources of Michigan is available from the Lake States Forest Experiment Station and the Michigan Department of Conservation.

County	Total land area 1/	Forest land 2/			Total forest as a percent of county area
		Total	Commercial 3/	Noncommercial 4/	
	M acres	M acres	M acres	M acres	Percent
Alcona	433.3	380.3	367.0	13.3	87.8
Alger	584.3	550.0	538.8	11.2	94.1
Allegan	530.6	124.9	124.9	0	23.5
Alpena	363.5	260.0	257.6	2.4	71.5
Antrim	305.3	203.5	202.7	.8	66.7
Arenac	235.5	98.1	86.4	11.7	41.7
Baraga	578.6	541.5	539.0	2.5	93.6
Barry	351.4	52.8	49.1	3.7	15.0
Bay	285.4	53.1	53.0	.1	18.6
Benzie	202.2	144.0	143.6	.4	71.2
Berrien	371.2	50.4	49.0	1.4	13.6
Branch	323.8	35.9	35.9	0	11.1
Calhoun	453.8	45.1	45.1	0	9.9
Cass	312.3	54.8	54.8	0	17.5
Charlevoix	265.0	185.3	184.9	.4	69.9
Cheboygan	464.0	378.5	376.0	2.5	81.6
Chippewa	1,011.2	853.0	830.4	22.6	84.4
Clare	366.1	241.2	236.3	4.9	65.9
Clinton	365.4	32.7	32.7	0	8.9
Crawford	360.3	334.5	316.7	17.8	92.8
Delta	755.2	652.3	641.8	10.5	86.4
Dickinson	484.5	433.0	428.8	4.2	89.4
Eaton	362.9	35.1	35.1	0	9.7
Emmet	295.0	220.9	212.4	8.5	74.9
Genesee	412.2	59.8	59.8	0	14.5
Gladwin	321.9	184.1	161.4	22.7	57.2
Gogebic	711.7	623.0	588.8	34.2	87.5
Grand Traverse	297.0	176.0	173.2	2.8	59.3
Gratiot	362.2	56.7	56.7	0	15.7
Hillsdale	384.6	44.0	44.0	0	11.4

(Footnotes and continuation of table on back of sheet)

V. E. FINDELL, Forester
Lake States Forest Experiment Station

R. E. PFEIFER, Forester
Michigan Department of Conservation

OCTOBER 1958

County	Total land area 1/	Forest land 2/			Total forest as a percent of county area
		Total	3/ Commercial	4/ Noncommercial	
	M acres	M acres	M acres	M acres	Percent
Houghton	659.2	529.8	526.5	3.3	80.4
Huron	526.1	112.8	111.7	1.1	21.4
Ingham	357.8	38.1	38.1	0	10.6
Ionia	368.0	44.2	44.2	0	12.0
Iosco	350.1	248.9	235.6	13.3	71.1
Iron	766.1	690.9	675.1	15.8	90.2
Isabella	366.1	105.6	105.6	0	28.8
Jackson	451.2	58.3	56.7	1.6	12.9
Kalamazoo	362.9	40.0	40.0	0	11.0
Kalkaska	361.0	299.4	297.1	2.3	82.9
Kent	551.7	98.0	97.1	.9	17.8
Keweenaw	348.2	319.5	191.5	128.0	91.8
Lake	366.1	318.2	318.2	*	86.9
Lapeer	421.8	106.9	103.8	3.1	25.3
Leelanau	223.4	130.4	130.2	.2	58.4
Lenawee	482.5	63.1	61.8	1.3	13.1
Livingston	365.4	96.8	86.7	10.1	26.5
Luce	585.0	542.2	517.0	25.2	92.7
Mackinac	649.0	593.9	588.9	5.0	91.5
Macomb	307.8	35.6	34.8	.8	11.6
Manistee	357.1	252.3	251.2	1.1	70.7
Marquette	1,178.2	1,125.1	1,121.3	3.8	95.5
Mason	315.5	182.8	181.2	1.6	57.9
Mecosta	360.3	165.2	165.0	.2	45.9
Menominee	660.5	520.3	511.8	8.5	78.8
Midland	332.8	191.6	184.1	7.5	57.6
Missaukee	361.6	236.9	236.3	.6	65.5
Monroe	359.7	36.9	36.8	.1	10.3
Montcalm	455.7	108.9	108.5	.4	23.9
Montmorency	355.2	308.1	307.7	.4	86.7
Muskegon	322.6	155.7	154.4	1.3	48.3
Newaygo	548.5	360.9	346.9	14.0	65.8
Oakland	561.3	127.2	103.6	23.6	22.7
Oceana	343.0	176.2	173.9	2.3	51.4
Ogemaw	367.4	273.9	271.7	2.2	74.6
Ontonagon	845.3	737.8	677.1	60.7	87.3
Osceola	371.8	196.0	195.9	.1	52.7
Oscoda	361.6	334.7	334.3	.4	92.6
Otsego	339.2	284.6	282.7	1.9	83.9
Ottawa	361.0	64.0	63.9	.1	17.7
Presque Isle	418.5	323.2	318.6	4.6	77.2
Roscommon	333.4	304.9	304.1	.8	91.4
Saginaw	519.7	110.5	110.5	0	21.3
St. Clair	473.6	106.6	105.1	1.5	22.5
St. Joseph	325.1	42.4	42.4	0	13.0
Sanilac	615.0	89.0	89.0	*	14.5
Schoolcraft	767.4	696.0	661.8	34.2	90.7
Shiawassee	345.6	38.8	38.8	0	11.2
Tuscola	522.2	122.5	122.5	0	23.5
Van Buren	388.5	68.5	68.5	0	17.6
Washtenaw	458.2	87.8	75.4	12.4	19.2
Wayne	388.5	35.4	33.9	1.5	9.1
Wexford	360.3	256.5	255.3	1.2	71.2
State total	36,494.1	19,698.3	19,120.7	577.6	54.0

1/ 1950 Bureau of Census.

2/ Includes (a) lands that are at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting influence on the climate or on the water regime; (b) land from which the trees described in a have been removed to less than 10 percent stocking and which has not been developed for other use; and (c) afforested areas. (Forest tracts of less than 1 acre, isolated strips of timber less than 120 feet wide, and abandoned fields and pastures not yet 10 percent stocked are excluded.) Forest areas of 1 million acres are subject to a sampling error of 1.5 percent.

3/ Forest land which is producing or capable of producing operable crops of sawtimber, pulpwood, or products of comparable size and value within 100 years and is not withdrawn from timber utilization.

4/ Forest land (a) withdrawn from timber utilization through statute, ordinance, or administrative order but that otherwise qualifies as commercial forest land; or (b) incapable of yielding usable wood products because of adverse site conditions.

* Less than 50 acres.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 546

Costs of Marking Black Spruce for Cutting in Northern Minnesota

Forest managers are aware that the cost of marking a stand of timber for cutting has an influence on their net return. But information on the extent of this influence and on how these costs vary with different marking methods generally has not been available. In a recent study it was found that the time required to mark a cord of black spruce was significantly different for various methods and intensities of cutting. In some cases, the marking cost amounted to a sizable proportion of the stumpage value of the timber cut.

During 1948 to 1950, a study to determine the effects of cutting intensities on the growth of black spruce in northern Minnesota was established on the Big Falls Experimental Forest by the Lake States Forest Experiment Station in cooperation with the Minnesota State Division of Forestry. Records were kept of the marking costs on 3 compartments clear cut in patches (14 patches from 0.2 to 0.5 acre in size), on 3 compartments clear cut in strips (5 strips from 0.7 to 1.6 acres in size), and on 10 partial-cut areas from 6.7 to 9.4 acres in size. The estimated volumes marked for cutting on the clear-cut areas varied from 18 to 28 cords per acre, while on the partial-cut areas they varied from 14 to 17 cords per acre under the shelterwood system and from 5 to 9 cords per acre under the light selection cutting systems. Trees to be cut ranged from 4 to 13 inches in diameter, although more than half of them fell within the 4- to 6-inch diameter range.

Marking was done with paint guns. Boundaries of the areas to be clear cut were designated, but individual trees were not marked. On partial-cut areas where less than half of the stand volume was to be cut (light selection cuts), individual trees to be cut were marked. On partial-cut areas where more than half of the stand volume was to be cut (shelterwood cuts), the trees to be left in the residual stand were marked.

An analysis of the costs showed that it took about twice as long to mark a cord of black spruce under the shelterwood system and nearly five times as long under the light selection cut system, where individual trees were marked, as under the clear-cut system where area boundaries were designated (table 1).

Table 1.--Marking time per cord of black spruce, for various cutting methods, Big Falls Compartment Study, 1948-1950

(In man-hours per cord)

Cutting method	Mean marking time	95-percent confidence interval of the mean marking time
Clear cut	0.065	± 0.017
Shelterwood	0.120	± 0.035
Light selection	0.300	± 0.072

JANUARY 1959

ALLEN L. LUNDGREN, Forest Economist

(Over)

MAINTAINED AT ST. PAUL 1, MINNESOTA IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

A more detailed examination of marking costs for light selection cuts revealed a highly significant relationship between marking time per cord and the number of trees marked per acre. Marking times ranged from 0.16 man-hours per cord when 320 trees per acre were marked, to 0.39 man-hours per cord when only 200 trees per acre were marked (table 2).

Table 2.--Marking time per cord of black spruce for various intensities of light selection cutting, Big Falls Compartment Study, 1948-1950

(In man-hours per cord)

Number of trees marked for cutting (per acre)	Estimated marking time	95-percent confidence interval of estimated marking time
200	0.39	± 0.05
220	0.35	± 0.04
240	0.31	± 0.03
260	0.27	± 0.03
280	0.24	± 0.04
300	0.20	± 0.05
320	0.16	± 0.07

If an average wage of $2 an hour for timber markers is assumed for purposes of illustration, the labor cost of marking on the areas studied would have averaged $0.13 per cord on clear-cut areas, $0.24 per cord on shelterwood areas, and from $0.32 to $0.78 per cord on light selection cutting areas. With black spruce stumpage selling at from $4 to $6 a cord, the labor cost alone for marking light selection cuts could amount to a substantial part (up to 20 percent) of the gross stumpage receipts. In contrast, the labor cost of marking clear-cut areas would be only 2 or 3 percent of the stumpage return.

Other expenses, such as the cost of paint and travel time to the cutting area, should be included in the total marking cost. Although no record of these costs was kept on this particular study, records from other studies indicate that such expenses may amount to about 10 or 20 percent of the labor cost.

The range of marking costs found in this study illustrates how partial cuttings may increase management costs. In selecting an appropriate cutting system, the forest manager should weigh carefully the expected returns against the costs incurred under each system.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 547

Commercial Forest Land in Michigan by Forest Type and County

About 64 percent of Michigan's commercial forest land is occupied by hardwoods. The two largest types, aspen and northern hardwoods, each make up about one-fourth of the area; other hardwood types such as oak, ash-elm, and cottonwood, account for about 14 percent. Softwood types make up about 20 percent. The remainder, about 16 percent of the commercial forest area, is nonstocked.

These figures and other timber resource information are the product of a cooperative forest survey made from 1946-56 by the Forest Service, U. S. Department of Agriculture, and the Michigan Department of Conservation, with participation by forest industries and other public agencies in some areas.

The determination of area by types was accomplished by the use of 40-acre sample blocks in the more heavily forested areas and dot sampling in the agricultural and industrial area. The total commercial forest area is subject to a sampling error of ± 1.5 percent (1 standard deviation). The sampling error for any one type or county would be greater. Very small figures may be considerably in error but are indicative of relative size.

(In thousands of acres)

County	Total commercial forest land area 1/	Forest type 2/						
		White and red pine 3/	Jack pine 4/	Other conifers 5/	Northern hardwoods 6/	Aspen 7/	Other hardwoods 8/	Non-stocked 9/
Alcona	367	12	27	30	11	156	73	58
Alger	539	19	14	73	256	96	20	61
Allegan	125	4	6	2	18	7	74	14
Alpena	258	7	9	41	31	100	28	42
Antrim	203	4	4	14	105	29	5	42
Arenac	86	1	2	3	2	49	14	15
Baraga	539	7	20	72	302	73	1	64
Barry	49	-	-	1	7	2	33	6
Bay	53	*	-	-	3	18	15	17
Benzie	144	5	5	8	49	28	10	39
Berrien	49	*	-	*	14	2	25	8
Branch	36	-	-	*	5	1	23	7
Calhoun	45	-	-	1	2	-	35	7
Cass	55	-	-	1	9	2	34	9
Charlevoix	185	2	2	22	85	31	8	35
Cheboygan	376	19	24	37	91	119	24	62
Chippewa	830	36	84	159	172	232	20	127
Clare	236	5	9	5	7	114	33	63
Clinton	33	-	-	*	7	1	18	7
Crawford	317	16	95	23	11	68	58	46
Delta	642	23	35	164	130	202	18	70
Dickinson	429	5	3	87	94	173	8	59
Eaton	35	-	-	*	14	1	15	5
Emmet	212	5	3	15	86	54	8	41
Genesee	60	*	*	*	11	11	24	14
Gladwin	162	3	5	5	5	94	29	21
Gogebic	589	8	5	68	297	109	25	77
Grand Traverse	173	11	16	11	31	20	24	60
Gratiot	57	*	-	*	8	12	18	19
Hillsdale	44	-	-	*	11	1	26	6
Houghton	526	6	20	27	366	79	6	22
Huron	112	1	1	1	14	44	29	22
Ingham	38	-	-	*	6	1	23	8
Ionia	44	*	*	*	11	2	23	8
Iosco	236	17	54	18	3	60	58	26

(Footnotes and continuation of table on back of sheet)

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Michigan Department of Conservation

JANUARY 1959

MAINTAINED AT ST. PAUL 1, MINNESOTA IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

(In thousands of acres)

County	Total commercial forest land area 1/	White and red pine 3/	Jack pine 4/	Other conifers 5/	Northern hardwoods 6/	Aspen 7/	Other hardwoods 8/	Non-stocked 9/
		Forest type 2/						
Iron	675	16	2	105	276	170	8	98
Isabella	106	-	-	3	7	39	23	34
Jackson	57	-	-	2	-	1	46	8
Kalamazoo	40	-	-	*	6	1	26	7
Kalkaska	297	10	30	15	57	53	28	104
Kent	97	2	*	*	18	8	57	12
Keweenaw	192	8	*	42	101	31	4	6
Lake	318	21	41	4	14	53	151	34
Lapeer	104	1	-	1	24	13	46	19
Leelanau	130	5	1	2	74	22	7	19
Lenawee	62	*	-	1	18	1	30	12
Livingston	87	-	-	2	8	4	41	32
Luce	517	25	49	144	166	51	8	74
Mackinac	589	16	13	153	121	207	12	67
Macomb	35	1	-	*	7	5	16	6
Manistee	251	13	14	8	30	45	99	42
Marquette	1,121	20	27	240	333	262	21	218
Mason	181	11	19	6	16	46	59	24
Mecosta	165	3	1	2	16	55	25	63
Menominee	512	9	4	134	114	177	20	54
Midland	184	2	5	5	6	105	28	33
Missaukee	236	11	12	9	35	79	32	58
Monroe	37	-	-	*	6	1	27	3
Montcalm	108	1	1	1	8	15	67	15
Montmorency	308	22	31	28	39	106	26	56
Muskegon	154	9	5	1	11	17	97	14
Newaygo	347	24	18	4	17	66	134	84
Oakland	104	*	*	4	18	14	50	18
Oceana	174	12	2	3	23	28	55	51
Ogemaw	272	6	28	14	15	131	49	29
Ontonagon	677	14	7	33	319	224	12	68
Osceola	196	12	6	6	32	69	24	47
Oscoda	334	19	91	13	8	85	67	51
Otsego	283	10	13	22	95	71	16	56
Ottawa	64	8	8	2	9	3	28	6
Presque Isle	319	16	17	60	30	124	23	49
Roscommon	304	16	32	23	5	111	71	46
Saginaw	110	1	-	-	10	26	46	27
St. Clair	105	1	-	*	26	15	46	17
St. Joseph	42	-	-	1	2	-	31	8
Sanilac	89	1	*	1	7	29	26	25
Schoolcraft	661	35	61	140	123	137	14	151
Shiawassee	39	-	-	-	10	2	17	10
Tuscola	122	1	*	1	19	49	34	18
Van Buren	68	-	-	*	12	6	35	15
Washtenaw	75	-	-	1	11	2	46	15
Wayne	34	-	-	*	6	1	22	5
Wexford	255	20	24	14	69	48	27	53
Total	19,121	618	1,005	2,138	4,651	4,799	2,762	3,148

1/ Forest land which is producing or capable of producing operable crops of sawtimber, pulpwood, or products of comparable size and value within 100 years and is not withdrawn from timber utilization.

2/ Forest type is based on the predominance of the key species.

3/ Pine species predominating with red and white pine most common.

4/ Pine species predominating with jack pine most common.

5/ Other conifers includes swamp conifers (black spruce, tamarack, and cedar) and upland white spruce-balsam fir types.

6/ Sugar maple, yellow birch, and beech predominating.

7/ Aspen and paper birch predominating.

8/ Other hardwoods includes bottomland hardwood (ash and elm), oak, and cottonwood types.

9/ Lands qualifying as forest but failing to meet the specifications for sawtimber,poletimber, or restocking stands. Includes grass and brush areas.

* Less than 500 acres.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 548

Net Timber Volume in Michigan by Species Group and County

Commercial forests of Michigan contain 134 million cords of timber growing stock; slightly more than one-half of this is in the Upper Peninsula. Marquette County with 8,668,000 cords has more growing stock than any other county in the State. Three other counties, all located in the Upper Peninsula, contain over 5 million cords each.

The soft hardwoods comprise 45 percent of the total growing stock volume, hard hardwoods 31 percent, and softwoods 24 percent. Pines make up the largest portion of softwood volume in the Lower Peninsula, but spruce and fir predominate in the Upper Peninsula.

Sawtimber volume is fairly evenly divided between the two peninsulas and between the four districts. Softwood sawtimber ranges from a high of 43 percent of the district total in the eastern Upper Peninsula to a low of 2 percent in the southern Lower Peninsula. Sugar maple is the leading sawtimber species in the Upper Peninsula. In the Lower Peninsula the oaks lead, followed closely by elm.

These and other forest resource statistics are the products of a cooperative Forest Survey conducted from 1946-56 by the Forest Service, U. S. Department of Agriculture, and the Michigan Department of Conservation with participation by forest industries and other public agencies in some areas. Additional information pertaining to the forest resources of Michigan is available from the Lake States Forest Experiment Station and the Michigan Department of Conservation.

County	Growing stock[1/]							Sawtimber[2/]											
	Total	Pine	Spr. & fir	Tam. & ced.	Hemlock	Hard[3/] hdwds.	Soft[4/] hdwds.	Total	W&R pine	Hemlock	Other con.	Sugar maple	Red maple	Yel. birch	Basswood	Beech	Elm	Red oak	Other hdwds.
	Thousand cords[5/]							Million board-feet[6/]											
EASTERN UPPER PENINSULA																			
Alger	5,371	311	438	342	700	1,929	1,651	1,223	72	258	106	320	74	98	17	146	29	9	94
Chippewa	5,706	738	872	684	208	977	2,227	940	126	71	217	111	57	55	8	59	27	2	207
Delta	4,335	435	639	587	197	644	1,833	571	74	66	139	76	29	31	5	28	20	1	102
Luce	4,484	576	616	445	403	1,359	1,085	1,018	117	146	185	202	78	111	11	104	22	1	41
Mackinac	4,395	257	738	704	160	745	1,791	651	69	54	172	85	38	41	7	44	19	2	120
Menominee	3,798	185	481	561	164	678	1,729	516	43	58	103	102	20	29	7	34	21	1	98
Schoolcraft	3,859	564	505	477	209	728	1,376	639	102	71	132	99	41	40	5	42	21	1	85
Total	31,948	3,066	4,289	3,800	2,041	7,060	11,692	5,558	603	724	1,054	995	337	405	60	457	159	17	747
WESTERN UPPER PENINSULA																			
Baraga	4,681	266	632	281	230	1,994	1,278	954	68	91	198	378	30	93	26	*	5	12	53
Dickinson	1,564	139	248	179	10	192	796	143	27	4	47	15	1	8	4	*	3	2	32
Gogebic	4,841	76	415	240	424	1,819	1,867	936	14	149	107	356	30	127	28	-	50	3	72
Houghton	4,284	158	234	134	182	1,736	1,840	746	17	62	76	274	70	112	31	-	25	5	74
Iron	4,366	343	490	252	91	1,474	1,716	782	89	36	106	293	22	85	18	-	37	1	95
Keweenaw	2,298	146	477	274	10	749	642	518	50	3	200	97	23	65	6	-	-	17	57
Marquette	8,668	788	1,017	730	1,131	2,596	2,406	1,953	212	392	372	468	38	135	42	16	2	78	198
Ontonagon	6,138	155	460	205	755	1,994	2,569	1,215	24	274	135	402	53	127	37	-	33	4	126
Total	36,840	2,071	3,973	2,295	2,833	12,554	13,114	7,247	501	1,011	1,241	2,283	267	752	192	16	155	122	707

(Footnotes and continuation of table on back of sheet)

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JANUARY 1959

NORTHERN LOWER PENINSULA

County	Growing stock[1/] Total	Pine	Spr. & fir	Tam. & ced.	Hem-lock	Hard[3/] hdwds.	Soft[4/] hdwds.	Sawtimber[2/] Total	W&R pine	Hem-lock	Other con.	Sugar maple	Red maple	Yel. birch	Bass-wood	Beech	Elm	Red oak	Wh. oak	Other hdwds.
	Thousand cords[5/]							Million board-feet[6/]												
Alcona	1,700	235	77	121	17	270	980	130	36	4	25	1	1	2	2	1	8	14	5	31
Alpena	1,507	131	127	122	29	231	867	133	23	7	23	8	3	1	5	3	18	11	4	27
Antrim	1,263	37	34	52	22	380	738	161	9	4	8	24	9	1	14	25	35	5	1	26
Arenac	418	20	9	22	1	59	307	42	4	*	2	1	3	*	3	*	11	3	3	12
Benzie	831	26	12	31	22	311	429	125	4	6	5	23	5	1	9	23	28	6	1	14
Charlevoix	1,190	38	40	63	22	336	691	130	9	6	10	19	8	1	11	15	28	5	1	17
Cheboygan	1,902	203	78	111	34	429	1,047	208	36	8	22	18	6	1	11	12	24	18	4	48
Clare	1,209	54	19	60	4	140	932	134	13	*	6	3	11	*	14	1	36	6	8	36
Crawford	1,251	426	51	54	7	226	487	116	27	2	36	1	1	*	2	1	6	16	5	19
Emmet	1,298	52	33	59	23	362	769	150	12	5	8	22	5	*	13	15	24	11	1	34
Gladwin	820	44	16	39	3	126	592	80	8	1	5	2	6	*	5	*	18	7	6	22
Gr. Traverse	943	89	22	52	24	312	444	136	17	6	10	15	5	1	7	12	29	14	4	16
Iosco	1,199	268	37	71	9	191	623	112	26	2	23	1	5	*	4	*	15	9	6	21
Kalkaska	1,002	140	20	37	21	292	492	136	20	5	15	13	3	1	6	10	22	23	4	14
Lake	1,896	194	10	41	14	925	712	242	15	3	21	7	10	2	6	4	24	100	24	26
Leelanau	1,211	50	14	26	22	434	665	187	16	6	4	32	8	*	16	29	37	13	1	25
Manistee	1,598	97	13	28	17	750	693	236	15	5	10	16	11	2	9	11	33	80	18	26
Mason	1,161	77	9	42	14	422	597	149	8	4	8	8	10	2	7	6	28	37	9	22
Mecosta	941	26	1	20	28	229	637	130	8	7	3	10	7	1	6	7	32	17	6	26
Midland	994	43	21	51	3	122	754	100	9	*	5	3	9	*	8	1	26	4	8	27
Missaukee	1,028	61	25	36	12	287	607	107	9	4	6	7	4	1	4	6	15	26	7	18
Montmorency	1,606	237	94	91	19	246	919	142	35	4	23	7	2	1	5	3	10	11	4	37
Newaygo	1,956	140	3	45	35	846	887	307	36	9	8	11	15	1	10	10	56	90	25	36
Oceana	1,258	44	1	26	43	479	665	223	11	12	4	14	16	2	12	16	55	38	11	32
Ogemaw	1,564	205	61	75	10	264	949	123	25	2	18	2	2	2	3	1	18	15	4	31
Osceola	1,258	27	8	29	23	303	868	148	4	8	4	15	11	2	12	15	28	17	5	27
Oscoda	1,673	584	41	64	8	262	714	171	60	3	45	1	*	1	1	1	6	14	4	35
Otsego	1,343	99	43	62	26	352	761	144	14	6	15	17	5	1	10	10	21	12	2	31
Presque Isle	1,478	156	140	147	19	205	811	125	32	4	23	7	2	1	4	3	12	9	3	25
Roscommon	1,352	210	43	68	10	289	732	120	32	2	20	1	2	1	2	*	8	22	5	25
Wexford	1,139	67	17	39	23	315	678	122	5	6	7	11	7	1	7	10	22	23	3	20
Total	39,989	4,080	1,119	1,784	564	10,395	22,047	4,569	578	141	422	320	192	30	228	251	733	676	192	806

SOUTHERN LOWER PENINSULA

County	Growing stock Total	Pine	Spr. & fir	Tam. & ced.	Hem-lock	Hard hdwds.	Soft hdwds.	Sawtimber Total	W&R pine	Hem-lock	Other con.	Sugar maple	Red maple	Yel. birch	Bass-wood	Beech	Elm	Red oak	Wh. oak	Other hdwds.
Allegan	1,020	12	-	5	-	493	510	235	4	-	1	31	23	-	6	24	46	41	18	41
Barry	529	3	-	2	-	284	240	134	1	-	*	12	15	-	3	11	22	35	16	19
Bay	308	9	1	5	*	82	211	70	4	-	1	4	6	-	6	1	21	9	7	11
Berrien	534	5	-	1	-	262	266	159	2	-	*	21	12	-	8	18	30	29	11	28
Branch	376	-	-	2	-	167	207	103	-	-	*	10	14	-	4	4	26	17	16	12
Calhoun	439	*	-	2	-	227	210	111	-	-	*	4	11	-	2	2	27	25	27	13
Cass	663	2	-	2	-	359	300	199	1	-	*	17	12	-	7	16	34	59	19	34
Clinton	267	-	-	1	-	104	162	71	-	-	*	12	7	-	4	4	24	6	7	7
Eaton	334	*	-	1	-	148	185	94	*	-	*	28	10	-	6	8	27	3	4	8
Genesee	708	3	1	5	-	266	433	180	1	-	1	13	22	*	11	5	50	30	22	25
Gratiot	540	6	1	3	-	150	380	158	2	-	1	13	21	*	12	4	53	14	16	22
Hillsdale	483	-	-	1	-	284	198	134	-	-	*	20	11	-	5	6	24	25	28	15
Huron	930	10	3	12	2	298	605	190	3	*	2	15	18	*	14	6	52	27	22	31
Ingham	329	-	-	*	-	150	179	86	-	-	*	14	8	-	4	4	26	10	11	9
Ionia	466	10	-	2	-	214	240	119	3	-	*	24	16	*	5	10	25	17	8	11
Isabella	635	4	1	18	2	183	427	133	1	1	3	7	12	*	12	2	34	20	14	27
Jackson	568	-	-	3	-	329	236	151	-	-	*	1	15	-	2	*	26	44	45	18
Kalamazoo	423	1	-	1	-	207	214	112	*	-	*	8	7	-	7	6	22	29	12	21
Kent	1,052	37	*	7	13	506	489	239	11	4	1	23	32	1	9	15	43	55	22	23
Lapeer	1,177	4	2	9	-	445	717	322	2	-	1	28	41	*	19	9	94	47	38	43
Lenawee	802	1	*	1	-	438	362	239	*	-	*	33	21	1	11	11	49	49	34	30
Livingston	763	1	*	1	-	315	446	212	*	-	*	15	24	1	7	5	66	34	28	32
Macomb	360	3	1	1	-	160	195	90	1	-	*	8	9	*	4	3	22	18	12	13
Monroe	586	*	*	*	-	333	253	179	-	-	-	12	19	1	4	3	35	56	27	22
Montcalm	1,072	37	1	11	9	425	589	218	12	3	1	14	35	1	8	7	58	41	16	22
Muskegon	1,280	70	*	6	6	727	471	242	21	2	1	17	24	*	6	8	37	75	29	22
Oakland	1,029	4	1	18	-	484	522	259	1	-	1	23	22	1	12	8	61	49	42	39
Ottawa	420	11	*	2	5	196	206	95	3	2	*	9	15	*	4	6	19	19	9	9
Saginaw	1,082	17	2	7	4	321	731	293	6	1	1	19	36	*	21	6	93	33	32	45
St. Clair	1,194	2	1	5	3	486	697	332	1	1	1	30	36	*	23	12	89	51	43	45
St. Joseph	400	1	-	1	-	241	157	110	*	-	*	4	6	-	2	2	16	46	16	18
Sanilac	745	8	2	8	2	199	526	172	3	1	1	10	23	*	11	5	61	16	15	26
Shiawassee	488	7	*	1	-	182	298	136	2	-	1	14	15	*	12	5	39	17	14	17
Tuscola	1,095	11	3	10	2	375	694	236	3	*	3	22	23	*	17	9	62	34	27	36
Van Buren	693	1	-	2	-	301	389	186	*	-	*	19	16	-	8	17	45	33	14	34
Washtenaw	982	1	-	1	-	456	524	289	*	-	*	23	33	1	9	7	76	60	41	39
Wayne	366	1	*	*	*	207	158	95	*	*	*	7	8	*	3	3	17	24	18	15
Total	25,138	282	20	157	48	11,004	13,627	6,383	88	15	21	584	678	7	308	272	1,551	1,197	780	882
State total all districts	133,915	9,499	9,401	8,036	5,486	41,013	60,480	23,757	1,770	1,891	2,738	4,182	1,474	1,194	788	996	2,598	(2,984)		3,142

1/ Net volume of live sawtimber trees and live poletimber trees from stump to a minimum 4.0-inch top diameter (of central stem) inside bark. Does not include limbs and cull tree volume. Volumes of one billion cubic feet (12,500,000 cords) are subject to a sampling error of ± 2.3 percent (1 standard deviation).

2/ Net sawtimber volume of trees of commercial species that contain at least one merchantable sawlog with a minimum top diameter inside bark of 8.0 inches. All softwood species 9.0 inches or larger in diameter at breast height and all hardwood species 11.0 inches and larger are included.

3/ Sugar maple, yellow birch, beech, oak, and hickory.

4/ Aspen, elm, ash, basswood, etc.

5/ Standard survey cord of 80 cubic feet of solid wood.

6/ Board-feet by the International Log Rule 1/4-inch kerf.

* Signifies less than 500 cords or 500,000 board-feet.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 549

Needle Droop of Red Pine

During the 1956 and 1957 growing seasons, moderate to severe needle-droop symptoms were noted on numerous red pine plantations in the Lake States. In 1958 no new damage from this disease was observed.

Needle-droop symptoms develop when the cells at the base of the needle fascicle collapse. They may be produced on red pine by a number of different conditions, biotic or environmental or both. These conditions are:

1. Lack of available moisture. Environmental conditions such that the transpiration rate of the trees is high and the available moisture is low will cause the needles to droop and die. Red pine planted on open sandy sites with a dense ground cover of herbaceous plants or with a heavy sod seem most susceptible to this injury.

2. Frost. Red pine is more susceptible to summer frosts than any other conifer. Trees planted in frost pockets or depressions are often injured and show needle-droop symptoms while those on the slopes are not damaged.

3. Insects. A gall midge (Thecodiplosis) has been reported to oviposit at the base of red pine needles in late spring or early summer, causing the needles to collapse. When the injury is caused by insects, the condition is usually referred to as "needle blight."

4. Fungi. A species of Pullularia has been reported which, in conjunction with the gall midge, can produce the needle-droop symptom.

5. Other causes. Needle-droop symptoms have been observed where none of the above conditions seem to exist. The cause or causes of the injury under these circumstances need to be studied.

A plantation in north central Minnesota in which needle-droop symptoms were present was studied. The following tabulation summarizes the observations:

Number of trees observed	500
Percent of trees with needle-droop symptoms	89.0
Percent of trees with dead terminal	47.0
Average number of dead buds per tree	1.7

The above plantation was on an open sandy site with a dense ground cover of Carex, Poa, Equisetum, Rosa, and Comptonia species. Injury in this plantation probably occurred in the fall of 1955. None of the trees in this plantation have been killed, but all of the trees with dead terminal buds have lost 3 years' height growth and are deformed at this time. No injury was noted on jack pine in the same plantation.

(Over)

Previous reports of needle droop have indicated that damage is usually limited to loss of the affected needles. The extensive bud mortality noted in 1956 and 1957 caused more severe damage than is usually attributed to this type of symptom. In the Upper Peninsula of Michigan severe symptoms were also noted in depressions in some plantations. In these cases there was almost 100-percent mortality of the affected trees.

January 1959 NEIL A. ANDERSON, Plant Pathologist

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 550

Debarking Bigtooth Aspen With 2,4-D Amine Salt

Sodium arsenite has been effectively used as a bark-loosening agent for several years, but it must be handled with extreme caution because of its toxicity. Early tests in Lower Michigan indicated that non-toxic alkanolamine salt of 2,4-D and butoxy-ethanol ester of 2,4,5-T could be used to loosen bark on bigtooth aspen but were not effective on northern red oak.

In the spring of 1957 followup tests were started on aspen to compare the bark-loosening effects of the butoxy-ethanol ester formulation of 2,4,5-T, alkanolamine salt of 2,4-D, and sodium arsenite and to determine the effective period of application. A 5-percent solution by volume of 2,4,5-T in fuel oil was applied by three methods: in a frill girdle, directly on the bark with a backpack sprayer, and directly on the bark with a paint brush. The 2,4-D was applied in frill girdles at five concentrations: full strength, and diluted with water to 50-, 25-, 10-, and 5-percent solutions by volume. Sodium arsenite was applied in 40-percent water solution in frill girdles to serve as a reference of effectiveness for the other treatments. Each treatment was applied to five trees at approximately weekly intervals from May 22 through September 9.

The treatments were evaluated by determining the looseness of bark on trees felled prior to the sap-peeling season in April 1958. Sodium arsenite treatments applied through the middle of August gave the best results (table 1). Bark applications of 2,4,5-T gave good results through the first week in June, but applications in frill girdles were ineffective.

Undiluted alkanolamine salt of 2,4-D gave good results through July. A 50-percent concentration was equally effective until the last week of July, but the bark-loosening effects with the 25-percent concentration were good only with the treatments applied through June. Weaker concentrations of 2,4-D did not loosen the bark in any of the tests.

These tests show that concentrated or slightly diluted alkanolamine salt of 2,4-D in frill girdles can be substituted for sodium arsenite to loosen the bark of bigtooth aspen without appreciable reduction in effectiveness. The use of hormone herbicides, which reduce the safety hazard, may result in wider use of chemical bark-loosening techniques.

January 1959

RICHARD E. LOHREY
Research Forester

Table 1.--Effectiveness of herbicides[1] in loosening bark of bigtooth aspen

Treatment	May		June				July					August			September
	22	29	5	12	18	25	2	11	16	26	30	7	16	30	9
Sodium arsenite in frills	Very good →													Fair	Poor
2,4,5-T:															
Brushed on bark	Good →			Fair →			Poor →					No effect →			
Sprayed on bark	2/	Good →		Fair →		Poor →						No effect →			
In frills	2/	Poor →					No effect →								
2,4-D in frills:															
Undiluted	Good →											Fair	No effect →		
50-percent dilution	Good →										Fair →		No effect →		
25-percent dilution	Good →						Fair →		Poor →				No effect →		
10-percent dilution	Fair →							Poor →			No effect →				
5-percent dilution	Fair →			Poor →				No effect →							

1/ Very good - The bark was loose for the full merchantable height and easily removed around the entire trunk. The bark was often cracked or peeling on the standing tree.
Good - The bark was quite loose and a piece of bark 6 inches wide could be pulled off in a strip 6 or more feet long with little effort. The inner bark was often very fibrous when removed.
Fair - Bark was still tight around limbs and knots. When started with an axe, strips of bark 2 to 3 feet long could be pulled from the tree with some effort.
Poor - The bark was still alive and broke off in pieces rather than in long strips.
No effect - The bark was tight as on untreated trees; the chemical had had no effect in loosening the bark.

2/ Treatment not yet installed.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 551

Established Forest Plantations in Northern Lower Michigan, 1957

In 1957, established forest plantations covered more than half a million acres in 34 counties in northern Lower Michigan. About 204,000 acres are on national-forest land, 158,000 acres on State-forest land, and 154,000 acres on private land.

These acreages are compiled from a survey recently completed by the Lake States Forest Experiment Station, the Lower Michigan National Forest, the Michigan Department of Conservation, and Consumers Power Company. "Acres planted" to conifers, based on record summaries, have been reported in Technical Notes 539 and 544. The acreages presented here are "established forest plantings" as determined by more than 3,000 sample plots. Although about 660,000 acres were planted, only 517,000 acres were found to be "established" forest plantings. Of the difference, 81,700 acres were accounted failures because the planted trees number less than 100 per acre or native pine reproduction is more promising than the planted trees. Trees in windbreaks or other small plantings of less than 2½ acres make up the remainder. Only 14,700 acres of the failures have reverted to grass and brush.

Of the half-million acres of established forest plantings, 454,500 are seedlings and saplings, 62,000 acres are poletimber, and 400 acres are sawtimber (fig. 1).

Medium- and well-stocked plantations totaled 366,000 acres. Poor stocking was found on 116,400 acres of seedlings and saplings and 34,500 acres of poletimber (table 1).

Nearly 40 percent, 201,700 acres, of the established plantations have native tree overstories. Growth is very slow on understory trees. The release of suppressed plantations from overstory competition is, therefore, a primary plantation management problem. About 27,000 acres of these underplanted trees are now classed as medium- and well-stocked poletimber. For better growth most of these stands should be thinned during the next decade.

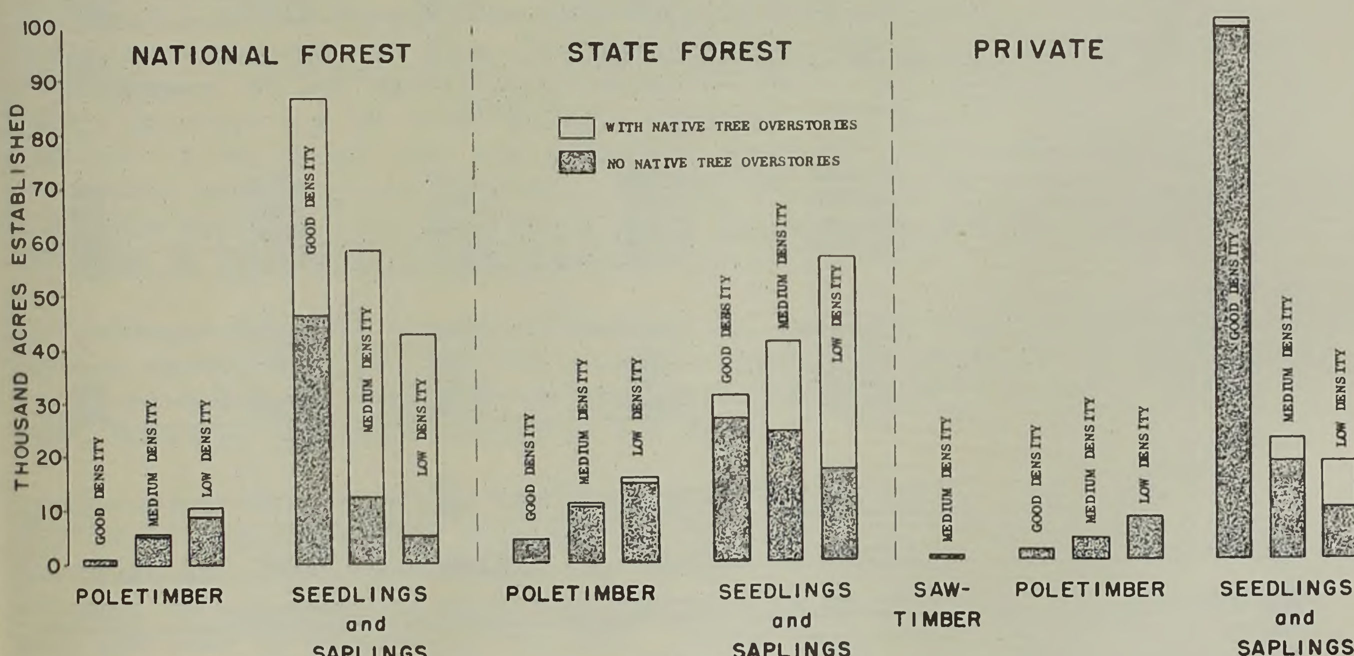


Figure 1. --Established forest plantation acreages in northern Lower Michigan by owner, size, and density.

JANUARY 1959

ROBERT N. STONE, Forester

Table 1.--Established forest plantations in northern Lower Michigan by owner, type, size, and density class, 1957

(In acres)

Stand-size and density[1/] class	Plantation type: All types	White pine	Red pine	Jack pine[2/]	Spruce
National Forest					
Seedlings and saplings:					
Low	42,400	6,900	33,600	1,700	200
Medium	58,300	2,900	46,200	8,700	500
Good	86,300	9,700	49,700	26,800	100
Total	187,000	19,500	129,500	37,200	800
Poletimber:					
Low	10,900	-	1,900	9,000	-
Medium	5,500	-	2,800	2,700	-
Good	1,000	-	700	300	-
Total	17,400	-	5,400	12,000	-
Total National Forest	204,400	19,500	134,900	49,200	800
State Forest[3/]					
Seedlings and saplings:					
Low	56,100	11,500	22,600	22,000	(5/)
Medium	40,200	2,900	14,100	23,200	(5/)
Good	30,800	1,600	10,500	18,600	100
Total	127,100	16,000	47,200	63,800	100
Poletimber:					
Low	16,000	400	1,900	13,300	400
Medium	10,800	600	1,700	8,500	-
Good	4,300	100	1,500	2,700	-
Total	31,100	1,100	5,100	24,500	400
Total State Forest	158,200	17,100	52,300	88,300	500
Private[4/]					
Seedlings and saplings:					
Low	17,900	8,300	5,700	2,800	1,100
Medium	22,400	3,600	12,800	4,400	1,600
Good	100,100	7,400	59,100	30,800	2,800
Total	140,400	19,300	77,600	38,000	5,500
Poletimber:					
Low	7,600	1,400	2,600	3,600	-
Medium	3,800	400	2,800	600	-
Good	2,100	400	1,500	-	200
Total	13,500	2,200	6,900	4,200	200
Sawtimber:					
Medium	400	-	400	-	-
Total	400	-	400	-	-
Total Private	154,300	21,500	84,900	42,200	5,700
All Owners	516,900	58,100	272,100	179,700	7,000
Percent of area with native tree overstories	39.0	64.2	43.5	26.7	13.1

1/ Stand density class definitions: Low density, 3-6.9 cords or 100-400 seedlings per acre; Medium density, 7-12.9 cords or 400-700 seedlings per acre; Good density, 13+ cords or 700+ seedlings per acre.

2/ Includes Scotch pine plantations.

3/ Excludes State forest plantings in Allegan County.

4/ Includes plantations on county and school forests and other small public holdings.

5/ Less than 50 acres.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 552

The Spread of Oak Wilt, 1955 to 1958

An annual survey to measure the spread of oak wilt has been conducted during the years 1955 to 1958 in central Wisconsin and southeastern Minnesota. The survey is performed by a two-man crew, and it is scheduled to allow a 1-year interval between remeasurements. Since the disease can be spread in two different ways, the survey is designed in two parts so as to obtain a measure of each method of spread.

The first part of the survey involves the measurement of the local spread of oak wilt through root grafts. For this purpose permanent sample plots were established in existing infection centers. By annually remeasuring the radii of the infected area on these plots, it is possible to determine whether the center has increased in size during the preceding 12 months.

The second part of the survey is concerned with the rate of establishment of new infection centers. For this purpose roadside samples of ½-chain-wide strips in the oak type were used. Resurveying the same strips annually and noting all infections that were not present in previous years gives a measure of the rate of new center establishment.

The results of the survey from 1955 to 1957 were published in Lake States Technical Notes 520 and 521. The data showed a fairly constant rate of establishment of new infection centers for the 3 years--approximately 1 new center annually per 60 acres of type sampled. During the 1958 remeasurement, however, it was found that the infection level had risen to a rate of 1 new center for each 45 acres sampled. Within this sample only the area in central Minnesota deviated from the upward trend for 1958 by showing a decrease in the rate of new center establishment.

The remeasurements to obtain information on the local rate of spread of the disease showed that in 1956 the permanent plots had an annual average radial spread of 3.5 feet. In 1957 the spread was found to be 4.4 feet. During 1958, however, the rate dropped to 2.6 feet.

Approximately 50 percent of the plots show wilt activity within any 1 year. The lowest percentage was obtained in 1958 when only 40 percent of the plots increased in size. Percentages for Jackson County, Wis., on the other hand, showed a marked increase from unusually low values of 25 and 21 percent for 1956 and 1957 to 36 percent for 1958. While this latest value tends to be more in line with the situation in the other counties, no explanation can be given as to why this increase occurred.

GERALD W. ANDERSON, Research Forester
RALPH L. ANDERSON, Plant Pathologist

January 1959

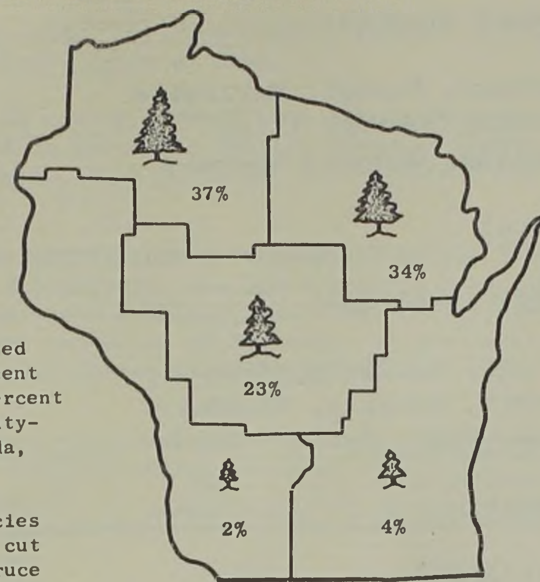
TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 553

Wisconsin Christmas tree harvest estimated at nearly 1-1/3 million trees, 1957

A survey recently completed by the Wisconsin Christmas Tree Producers' Association and summarized by the Lake States Station indicates that approximately 1-1/3 million Christmas trees were cut in Wisconsin during 1957. Some 1,500 licensed Christmas tree dealers transported and marketed most of the trees in cities and towns throughout Wisconsin and neighboring states. Licensed dealers from out-of-state shipped about 150,000 Wisconsin Christmas trees to other midwestern states. Nearly two-thirds of the exported trees were balsam fir; 25 percent were pine; and about 10 percent were spruce.



Where trees were cut, 1957

Christmas tree cutting operations were concentrated largely in the northern part of the State, with 37 percent of the cut coming from the Northwest district and 34 percent of the cut from the Northeast district (see map). County-wise the largest cuts were registered in Lincoln, Oneida, and Douglas Counties.

Balsam fir was the principal Christmas tree species accounting for about half of the total number of trees cut in the State. Pine was second with 26 percent, and spruce third with 20 percent. Altogether about 71 percent of the trees were cut from wildlands and 29 percent from plantations. Practically all the balsam fir was cut from wildlands in contrast to pine, which was harvested almost entirely from plantations.

Cuttings on small forest holdings accounted for about 90 percent of the total Christmas tree output; large private and public holdings together accounted for the remaining 10 percent.

Estimated number of Christmas trees cut by district, ownership, species, and type of land, 1957[1/]

(Thousand trees)

District and class of owner	All species			Pine		Spruce		Balsam fir	
	Total	Plantations	Wildland	Plantations	Wildland	Plantations	Wildland	Plantations	Wildland
Northeast district:	436	87	349	63	10	23	29	1	310
Public	24	16	8	16	-	-	1	-	7
Large private[2/]	32	17	15	9	-	8	-	-	15
Other private	380	54	326	38	10	15	28	1	288
Northwest district:	480	69	411	62	-	5	97	2	314
Public	6	5	1	5	-	-	*	-	1
Large private[2/]	10	10	*	10	-	*	-	-	*
Other private	464	54	410	47	-	5	97	2	313
Central district:	297	153	144	138	-	15	75	-	69
Public	19	19	-	19	-	-	-	-	-
Large private[2/]	46	39	7	39	-	-	7	-	-
Other private	232	95	137	80	-	15	68	-	69
SE and SW districts:	75	71	4	68	-	3	-	-	4
Public	9	9	-	9	-	-	-	-	-
Large private[2/]	-	-	-	-	-	-	-	-	-
Other private	66	62	4	59	-	3	-	-	4
State total:	1,288	380	908	331	10	46	201	3	697
Public	58	49	9	49	-	-	1	-	8
Large private[2/]	88	66	22	58	-	8	7	-	15
Other private	1,142	265	877	224	10	38	193	3	674

1/ The data shown are based on a mail canvass. The response was as follows: 35 percent of licensed Christmas tree dealers, 66 percent of WCTPA members, 52 percent large private landowners, and 100 percent public landowners; the average for all groups was 43 percent. Nonrespondents to questionnaire were not sampled; hence no accuracy statement is made.

2/ 5,000 acres or more.

* Less than 500 trees.

(Over)

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Wisconsin Christmas tree production by species and county groups within each district, 1957

(Thousand trees)

District and county[1/]	All species	Pine	Spruce	Balsam fir
Northeast district:				
Florence, Forest, Marinette	110	30	19	61
Lincoln, Oneida, Vilas	200	23	15	162
Langlade, Oconto, Shawano	126	20	18	88
Total	436	73	52	311
Northwest district:				
Ashland, Bayfield, Iron	124	16	54	54
Burnett, Douglas, Washburn	117	34	18	65
Price, Rusk, Sawyer, Taylor	239	12	30	197
Total	480	62	102	316
Central district:				
Marathon, Portage, Waupaca, Wood	87	32	18	37
Chippewa, Clark, Eau Claire	48	8	18	22
Jackson, Juneau, Monroe	42	16	24	2
Adams, Marquette, Waushara	120	82	30	8
Total	297	138	90	69
Southeast district:				
Brown, Door, Kewaunee, Outagamie	20	17	-	3
Columbia, Green Lake, Sheboygan	16	16	-	-
Green, Jefferson, Walworth, Waukesha	18	18	-	-
Total	54	51	-	3
Southwest district:				
Barron, Dunn, Trempealeau	12	9	3	-
Iowa, La Crosse, Sauk, Vernon	9	8	-	1
Total	21	17	3	1
State total	1,288	[2/] 341	[3/] 247	700

1/ Limited to those counties with a cut of 500 or more Christmas trees.
2/ Red pine 319,000, Scotch and white pines 22,000.
3/ White spruce 154,000, black spruce 93,000.

January 1959 ARTHUR G. HORN, Forest Economist

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 554

FOREST AREA IN WISCONSIN COUNTIES

The forests of Wisconsin in 1956 totaled 15.6 million acres. All but about 1 percent of this area is commercial forest land capable of producing usable crops of wood.

Forests occupy 44.5 percent of the total land area. By county, forest area ranges from 90 percent of the land area in Forest County to 3 percent in Milwaukee County. Douglas County with 684,900 acres of forest land had the largest amount, while Milwaukee County with 4,600 forested acres had the least.

Forest area and other forest resource information are results from a cooperative forest survey conducted by the Forest Service, U. S. Department of Agriculture, and the Wisconsin Conservation Department with participation by forest industries, northern counties, and other public agencies in some areas. Additional information about the timber resources of Wisconsin is available from the Wisconsin Conservation Department and the Lake States Forest Experiment Station.

County	Total land area[1]	Forest land[2]			Total forest as a percent of county area
		Total	Commercial[3]	Non-commercial[4]	
	M acres	M acres	M acres	M acres	Percent
Adams	433.3	249.2	246.8	2.4	57.5
Ashland	663.7	562.4	553.7	8.7	84.7
Barron	554.2	151.7	151.7	-	27.4
Bayfield	943.4	795.7	792.7	3.0	84.3
Brown	336.0	46.3	46.3	-	13.8
Buffalo	455.7	189.1	188.5	.6	41.5
Burnett	537.6	360.3	359.7	.6	67.0
Calumet	201.6	24.0	24.0	-	11.9
Chippewa	656.0	248.2	245.4	2.8	37.8
Clark	782.1	306.7	293.0	13.7	39.2
Columbia	497.9	120.5	120.5	-	24.2
Crawford	375.0	182.8	182.8	-	48.7
Dane	766.1	67.8	67.8	-	8.9
Dodge	570.9	31.2	31.2	-	5.5
Door	314.2	104.2	104.2	-	33.2
Douglas	838.4	684.9	681.4	3.5	81.7
Dunn	549.1	165.2	165.2	-	30.1
Eau Claire	415.4	167.4	165.3	2.1	40.3
Florence	313.0	276.8	271.3	5.5	88.5
Fond du Lac	463.4	34.2	33.3	.9	7.4
Forest	646.4	584.1	564.9	19.2	90.4
Grant	747.5	201.4	201.4	-	26.9
Green	375.0	25.7	25.7	-	6.8
Green Lake	227.2	26.4	26.4	-	11.6
Iowa	487.0	124.7	124.7	-	25.6
Iron	477.4	416.5	413.3	3.2	87.2
Jackson	640.0	353.7	325.0	28.7	55.3
Jefferson	361.0	32.6	32.6	-	9.0
Juneau	508.8	286.6	286.0	.6	56.3
Kenosha	174.7	11.3	11.3	-	6.5

(Footnotes and continuation of table on back of sheet.)

ROBERT N. STONE, Forester
Lake States Forest Experiment Station

HARRY W. THORNE, Forester
Wisconsin Conservation Department

APRIL 1959

County	Total land area[1]	Forest land[2] Total	Commercial[3]	Non-commercial[4]	Total forest as a percent of county area
	M acres	M acres	M acres	M acres	Percent
Kewaunee	211.8	37.2	37.2	-	17.6
La Crosse	300.2	121.6	121.6	-	40.5
Lafayette	411.5	36.0	36.0	-	8.7
Langlade	549.1	387.7	384.8	2.9	70.6
Lincoln	576.0	399.9	398.7	1.2	69.4
Manitowoc	377.0	62.2	62.2	-	16.5
Marathon	1,013.8	358.8	358.4	.4	35.4
Marinette	888.3	653.1	651.6	1.5	73.5
Marquette	292.5	86.2	86.2	-	29.5
Milwaukee	153.0	4.6	4.6	-	3.0
Monroe	585.6	273.6	253.7	19.9	46.7
Oconto	707.8	430.6	427.8	2.8	60.8
Oneida	713.0	583.6	581.3	2.3	81.8
Outagamie	405.8	67.5	67.5	-	16.6
Ozaukee	150.4	18.5	18.5	-	12.3
Pepin	151.7	49.1	49.1	-	32.4
Pierce	378.2	89.6	89.6	-	23.7
Polk	597.8	243.4	242.9	.5	40.7
Portage	518.4	150.7	150.7	-	29.1
Price	811.5	645.6	638.6	7.0	79.6
Racine	215.7	15.8	15.8	-	7.3
Richland	373.8	127.8	127.8	-	34.2
Rock	461.4	25.7	25.7	-	5.6
Rusk	582.4	362.3	361.0	1.3	62.2
Sauk	537.6	179.0	179.0	-	33.3
Sawyer	814.7	692.4	671.5	20.9	85.0
Shawano	752.6	403.6	403.5	.1	53.6
Sheboygan	323.8	56.3	56.3	-	17.3
St. Croix	471.0	68.1	68.1	-	14.5
Taylor	626.6	358.6	355.3	3.3	57.2
Trempealeau	473.0	119.2	119.2	-	25.2
Vernon	515.2	178.2	178.2	-	34.6
Vilas	554.9	476.3	472.7	3.6	85.8
Walworth	358.4	34.1	34.1	-	9.5
Washburn	522.2	370.0	370.0	-	70.8
Washington	273.9	39.6	39.6	-	14.5
Waukesha	355.8	38.9	38.9	-	10.9
Waupaca	480.6	147.9	147.6	.3	30.8
Waushara	401.9	131.4	131.4	-	32.7
Winnebago	290.6	17.5	17.5	-	6.0
Wood	519.7	214.0	185.5	28.5	41.2
State total	35,011.2	15,587.8	15,395.8	192.0	44.5

1/ 1950 Bureau of Census--includes bodies of water smaller than 40 acres.

2/ Includes (a) lands that are at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting influence on the climate or on the water regime; (b) land from which the trees described in a have been removed to less than 10 percent stocking and which has not been developed for other use; and (c) afforested areas. (Forest tracts of less than 1 acre, isolated strips of timber less than 120 feet wide, and abandoned fields and pastures not yet 10 percent stocked are excluded.) Forest areas of 1 million acres are subject to a sampling error of ± 1.3 percent.

3/ Forest land which is producing or capable of producing operable crops of sawtimber, pulpwood, or products of comparable size and value within 100 years and is not withdrawn from timber utilization.

4/ Forest land (a) withdrawn from timber utilization through statute, ordinance, or administrative order but that otherwise qualifies as commercial forest land, or (b) incapable of yielding usable wood products because of adverse site conditions.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 555

Further Observations on Seedbed Scarification Show Benefits to Northern Red Oak Were Temporary

Scarification of the soil improved the initial establishment of northern red oak reproduction and other associated tree species on a test area in the Hardies Creek Timber Harvest Forest.[1/] A reexamination of the same 10 transects 5 years later shows that this initial advantage in stocking has been largely lost.

Thus, in 1958, the total regeneration of the various hardwoods amounted to 5,199 trees per acre for the disked plots and 4,450 for the untreated checks (table 1). This means that those areas which were left in their natural state now have 86 percent as many small trees per acre as the strips which were torn up with a disk in 1951. Comparable data for 1953 were 2,701 versus 4,849 seedlings per acre or a 56:100 ratio in favor of scarification.

Table 1.--Comparative data for disked and undisked transects

No. of growing seasons and treatment	Northern red oak seedlings: Av. no. per acre	Northern red oak seedlings: Av. total height, inches[1/]	Northern red oak seedlings: Percent of milacres stocked with one or more seedlings	No. of seedlings of other hardwoods per acre
Two (1953):				
Disked	3,162	4.2	85	1,687
Not disked	940	6.3	60	1,761
Seven (1958):				
Disked	2,762	7.3	82	2,437
Not disked	2,500	7.7	79	1,950

1/ Based on individual measurements of all seedlings on all sample milacre quadrats.

An especially good response was obtained from disking in the bumper crop of northern red oak acorns on the ground in the fall of 1951 (3,162 and 940 red oak seedlings per acre for disked and undisked areas, respectively, in 1953). Therefore, it was concluded at that time that definite silvicultural benefits had been obtained by a partial tillage of the forest floor.

1/ Scholz, Harold F. 1955. Effect of scarification on the initial establishment of northern red oak reproduction. Lake States Forest Expt. Sta. Tech. Note 425, 2 pp. (Processed.)

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These fluctuations in the amount of hardwood regeneration on the two sets of plots have been associated with certain land-use changes and modifications in the structure of the main stand. Thus, prior to 1951 when the area was in private ownership, the Timber Harvest Forest was heavily grazed by dairy cows, whereas it was completely protected from livestock during the 7-year period ending in 1958.

There is tangible evidence that this extended protection has benefited both the forest stand and the site. An accumulation of leaves and twigs provides surface protection that formerly was lacking; annual weeds and agricultural grasses gradually are being supplanted by vegetation more typical of undisturbed mixed-oak woodlands; and there is a noticeable improvement in the tilth of the upper soil horizons.

Logging in this part of the demonstration forest has been limited to a shelterwood preparatory cut which took out about 30 trees per acre and reduced the basal area of the sawtimber stand from 139.8 square feet to 106.8 square feet (a reduction of 23.6 percent). About two-thirds of the trees harvested were in the suppressed and intermediate crown classes, and consequently their elimination from the stand did not open the main canopy as much percentagewise as it reduced the basal area.

The cessation of grazing and a moderate reduction in the number of sawtimber stems per acre may or may not account for the changes which have taken place in the hardwood regeneration complex on the disked and undisked plots during the last 5 years. Additional studies will be needed not only to determine this point, but also to explore the entire field of "oak-ecology" and the extent to which it can be manipulated to attain specific silvicultural objectives.

April 1959

HAROLD F. SCHOLZ,
Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 556

Trampling by Livestock Drastically Reduces Infiltration Rate of Soil in Oak and Pine Woods in Southwestern Wisconsin

Undisturbed forest soils, because of their high porosity, comparatively low bulk density, and rather deep surface organic layers, have an inherently high rate of infiltration.

This fact provides one of the most potent arguments for keeping steeper land in forest cover. However, when such forest land is subjected to trampling by livestock turned into the woods to graze, the infiltration rate of the soil is drastically reduced.

To obtain a measure of the relative reduction of infiltration rate due to intensive livestock use of the forests, a series of 48 infiltration tests were made. Steel cylinders 3 inches in diameter and 6 inches high were used. Twelve tests were made in each of four sites in the unglaciated region around La Crosse, Wis. Two sites were in native oak woods of sawlog size on loessal silt loam soil. Two others were in a Scotch pine plantation about 55 years old on a sandy loam soil. The cylinders were driven into the soil about 2 inches and then kept filled with water, with readings taken at 5, 10, 20, 30, 40, 50, 60, and 70 minutes thereafter. The infiltration rate for a 1-hour period excluding the first 10-minute wetting period is given below:

Cover	Infiltration in inches per hour
Ungrazed native oak woods	7.46
Grazed native oak woods	.05
Ungrazed Scotch pine plantation	11.02
Grazed Scotch pine plantation	1.23

Combining results of both areas, there is a 93-percent reduction in the cylinder infiltration rate due to livestock trampling. Statistical analysis of the data by "t" test showed the differences between grazed and ungrazed values to be significant at the 1-percent level. Since the native oaks and pines grew on different textured soils with inherently different infiltration rates, direct comparisons between the two cover types should not be made. The reduction within each cover as a result of trampling is valid, however. The comparative infiltration rates for all readings are shown graphically on the back of this sheet.

The bulk density (apparent specific gravity) of the surface 3 inches of soil in the oak woods was 1.15 and 0.89 respectively for grazed and ungrazed conditions, representing a 29.2-percent increase in density of the soil due to compaction.

April 1959

J. H. STOECKELER, Senior Soil Scientist

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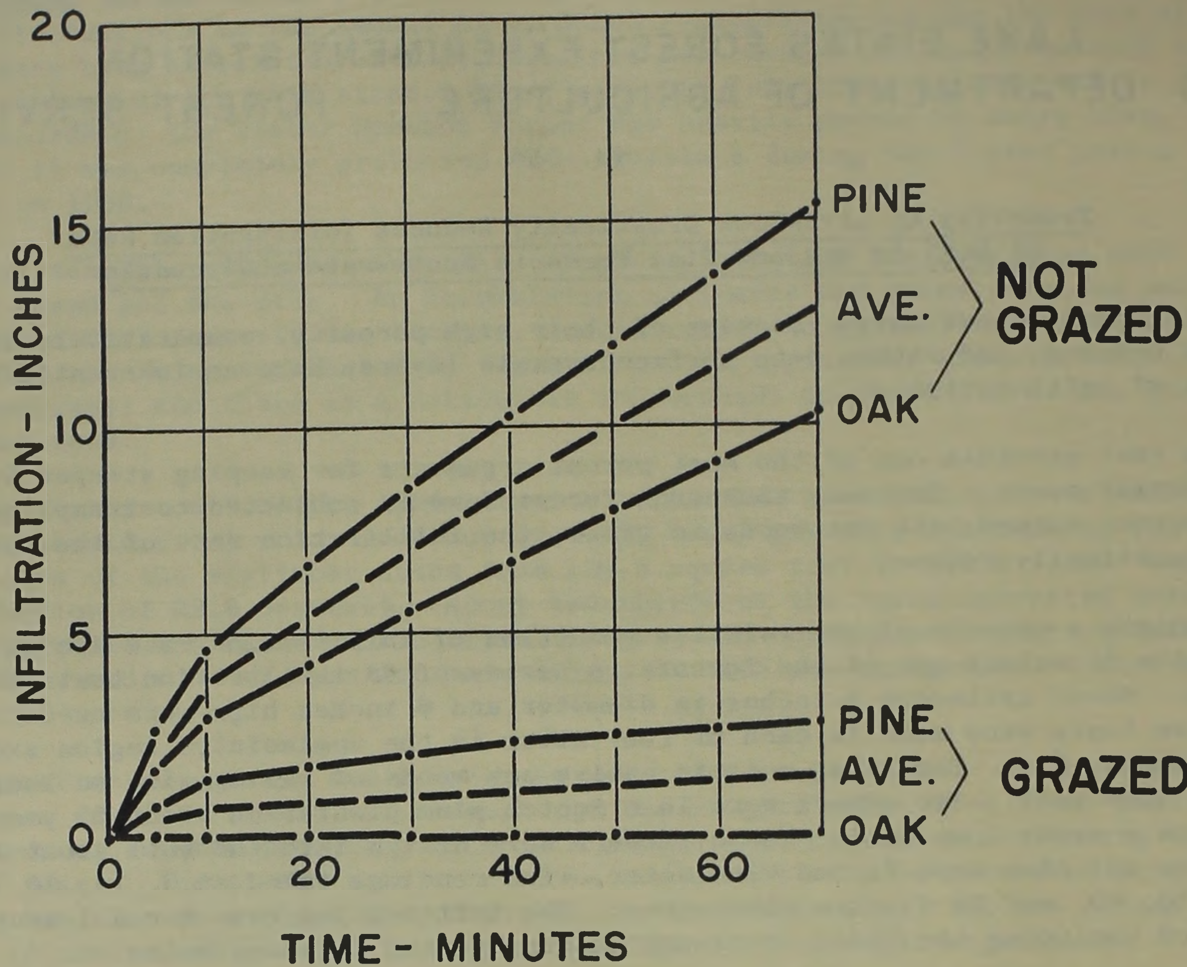

Deleterious effect of cattle trampling on water infiltration into soil in two types of forest cover, Sept. 25-27, near La Crosse, Wis. Rates were measured in 3-inch cylinders.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
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No. 557

The Effect of Time and Carbonizing Temperatures on Quality of Charcoal From a Cinder-Concrete Block Kiln

Charcoal produced in small cinder-concrete block kilns[1/] increases in volatile content from top to bottom of the charge according to results from nine burns on the Argonne Experimental Forest near Three Lakes, Wis. This is because carbonization begins at the top and proceeds downward through the load. However, the composition of the total kiln yields is within the requirements for good-quality, domestic-grade charcoal.

For general market acceptance, good-quality charcoal contains 75 percent or more fixed carbon, and associated volatiles should be less than 24 percent if the charcoal is not to smoke when burned.[2/]

The amount of retained volatiles depends upon the temperature during carbonization and the length of time the charcoal is held at this temperature. Volatiles decrease with an increase in either carbonization temperatures or time. Higher carbonization temperatures must be maintained in the upper levels of the kiln if the lower level temperatures are to be raised above the carbonization point; thus the volatile content of charcoal from the upper levels of the kiln load will usually be less than the volatile content from the lower levels.

For the nine burns, all kiln loads consisted of 4-foot rough sugar maple (*Acer saccharum* Marsh.) sticks, about 6 inches average diameter. Of the nine burns, three used green wood with center-firing and four stacks; three used air-dry wood with center-firing and four stacks; and three used air-dry wood with end-firing and one stack. To facilitate heat circulation, the 6-foot-high wood load was piled on 7-inch stringers. By using 24 evenly spaced thermocouples (8 in each 2-foot layer of the load), hourly carbonization temperatures were recorded for the 3 horizontal zones in the kiln.

In figure 1, average time-temperature curves for the nine burns illustrate why position in the load will cause charcoal to vary in volatile content. The average bottom temperatures did not reach 800° F. until 6 hours after the middle temperatures did. Previous experimental data have shown that average carbonizing temperatures should be above 800° F. at least 1 hour for good-quality charcoal.

1/ Lane, Paul H. Design of a cinder-concrete block charcoal kiln. Lake States Forest Expt. Sta. Tech. Note 494, 2 pp., illus. (Processed.) 1957.

2/ U. S. Forest Products Laboratory. Production of charcoal in a masonry block kiln--structure and operation. Rept. 2084, 32 pp. + 6 tables and 17 figures. (Processed.) 1957.

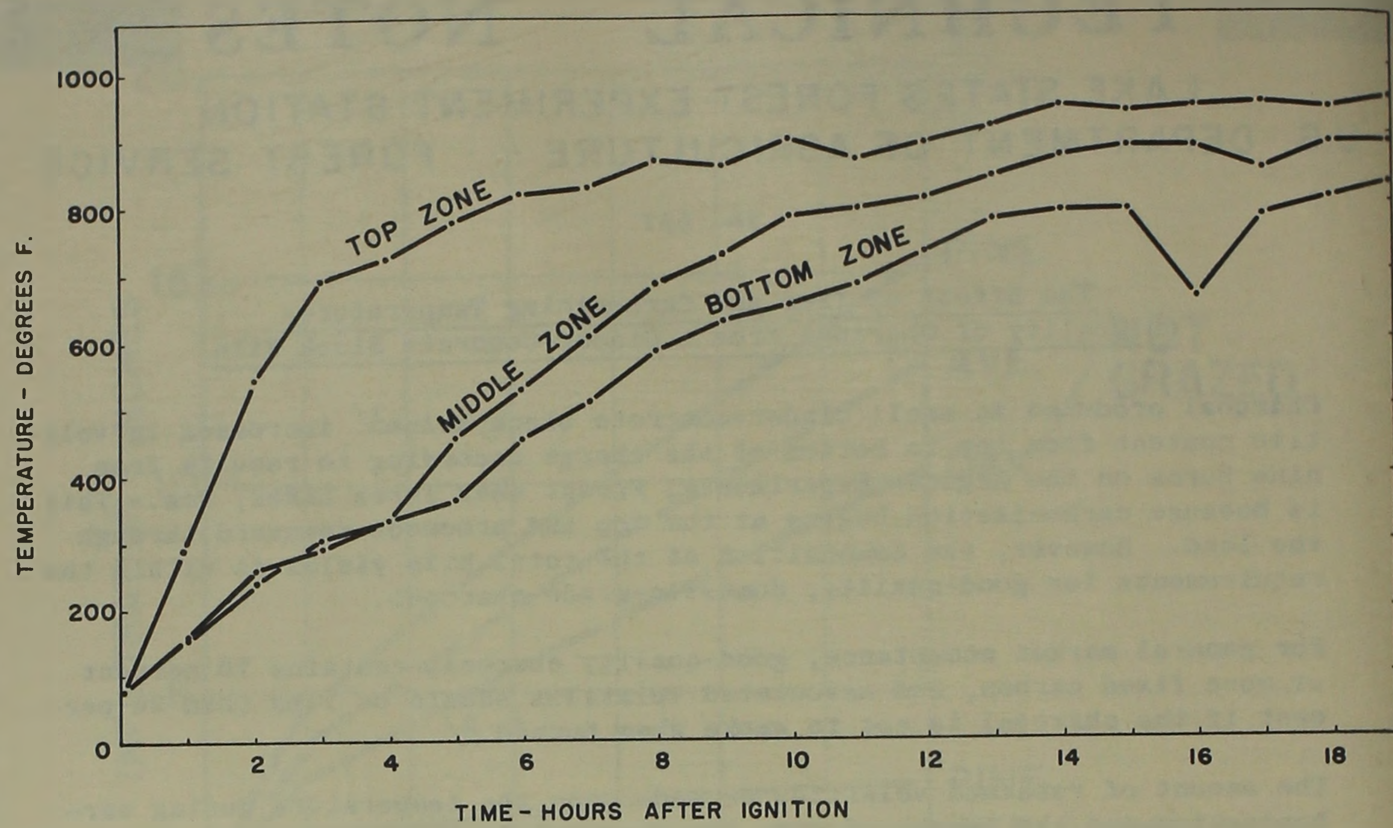

Figure 1.--Average kiln temperatures from nine experimental charcoal burns.
Note: The temperature drop at 16 hours for the lower zone was caused by restriction of air supply.

The average charcoal yield from the nine burns (103 kiln samples) was analyzed by the U. S. Forest Products Laboratory. The percentages of volatiles, ash, and fixed carbon, based on the ovendry weight of the charcoal, were as follows:

			Percent
Volatiles:	Top third of kiln	14.48	
	Middle third	16.58	
	Bottom third	24.67	
	Average		18.58
Ash			1.74
Fixed carbon			79.68
Total			100.00

Although the average volatile content for the bottom zone is rather high, the volatile content for total charcoal yield from all nine burns does not vary significantly from the 18.58-percent average. Apparently variation in moisture content and firing methods does not affect the quality of charcoal produced in this type of kiln.

JAMES C. WARD
Technologist (Forest Products)

April 1959

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No. 558

Lake States Pulpwood Production and Imports Decline in 1958

A recent survey made by the Station shows that local cutters harvested approximately 2,630,000 cords of pulpwood in the Lake States during 1958 (see table on back of sheet). This is about 11 percent less than the amount harvested in either 1957 or 1956. Each of the three Lake States showed a marked decrease in production. Compared with the previous year Minnesota production was down 14 percent, Wisconsin 11 percent, and Michigan 8 percent. Pulpwood shipped in from other states and Canada followed the same general pattern, dropping off 15 percent. Imports from the western states broke off sharply, declining 37 percent.

All species except pine (which increased 18 percent) showed a decrease from the previous year. The regional cut of miscellaneous hardwoods was only slightly less than the previous year; other species, however, declined rather sharply. The cut of birch declined 50 percent, spruce 29 percent, balsam fir and hemlock 23 percent, tamarack 11 percent, and aspen 10 percent. Although the cut of aspen was less than last year it continues to be the leading pulpwood species. The proportion it represents of the total cut seems to have stabilized between 40 and 45 percent.

Total receipts at Lake States mills were 3,114,000 cords, a decline of 12 percent from the previous year. Michigan's share of the wood receipts increased from 15 to 18 percent in 1958 (see following table). A larger proportion of the pine and miscellaneous hardwoods was channeled to the Michigan mills. Michigan's cut of pine more than doubled to meet not only the demands of resident mills but also of Wisconsin mills.

Geographic origin and destination of pulpwood received by Lake States mills, 1958

Species	Percent of pulpwood originating from:					Percent of pulpwood received by:		
	Minn.	Wisc.	Mich.	Canada	Other U. S.	Minn. mills	Wisc. mills	Mich. mills
Aspen	28	32	38	2	-	29	51	20
Balsam fir	36	19	36	9	-	17	62	21
Birch	9	87	3	1	-	10	90	-
Hemlock	-	61	39	-	-	-	100	-
Pine	34	25	25	10	6	28	54	18
Spruce	35	3	13	46	3	19	70	11
Tamarack	68	28	4	-	-	13	87	-
Misc. hdwds.	1/ 3	2/63	2/34	-	-	3	69	28
All species	29	26	29	14	2	22	60	18
Previous year (1957)	30	26	28	14	2	21	64	15

1/ Balsam poplar (balm-of-Gilead).
2/ Mostly dense hardwoods.

A. G. HORN
Forest Economist

APRIL 1959

(Over)

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Production and imports of pulpwood, Lake States, 1958

(In standard cords, unpeeled)

Species and destination	Production by states1/				Imports			Total receipts
	Minnesota	Wisconsin	Michigan	Region	Other2/ U. S.	Canada	Total imports	
Aspen								
Minn.	312,818	12,913	-	325,731	-	12,020	12,020	337,751
Wisc.	11,101	355,600	212,686	579,387	-	3,880	3,880	583,267
Mich.	-	-	221,215	221,215	-	12,558	12,558	233,773
Total	323,919	368,513	433,901	1,126,333	-	28,458	28,458	1,154,791
Balsam fir								
Minn.	55,259	-	-	55,259	-	86	86	55,345
Wisc.	58,268	62,006	78,508	198,782	-	915	915	199,697
Mich.	2,705	-	36,863	39,568	-	30,021	30,021	69,589
Total	116,232	62,006	115,371	293,609	-	31,022	31,022	324,631
Birch, white								
Minn.	1,858	-	-	1,858	-	246	246	2,104
Wisc.	-	18,013	708	18,721	-	-	-	18,721
Mich.	-	-	-	-	-	-	-	-
Total	1,858	18,013	708	20,579	-	246	246	20,825
Hemlock								
Minn.	-	-	-	-	-	-	-	-
Wisc.	-	55,270	35,129	90,399	-	-	-	90,399
Mich.	-	-	85	85	-	-	-	85
Total	-	55,270	35,214	90,484	-	-	-	90,484
Pine								
Minn.	122,780	1,026	-	123,806	-	37,366	37,366	161,172
Wisc.	74,729	147,138	41,292	263,159	32,775	22,365	55,140	318,299
Mich.	-	-	107,438	107,438	-	-	-	107,438
Total	197,509	148,164	148,730	494,403	32,775	59,731	92,506	586,909
Spruce								
Minn.	122,591	-	-	122,591	-	10,076	10,076	132,667
Wisc.	111,592	22,627	58,725	192,944	21,899	263,588	285,487	478,431
Mich.	4,456	-	27,565	32,021	-	41,358	41,358	73,379
Exported3/	2,838	-	-	2,838	-	-	-	-
Total	241,477	22,627	86,290	350,394	21,899	315,022	336,921	684,477
Tamarack								
Minn.	2,724	-	-	2,724	-	-	-	2,724
Wisc.	11,639	5,838	842	18,319	-	-	-	18,319
Mich.	-	-	-	-	-	-	-	-
Total	14,363	5,838	842	21,043	-	-	-	21,043
Misc. hdwds.								
Minn.4/	7,474	-	-	7,474	-	-	-	7,474
Wisc.4/	145	144,831	13,594	158,570	-	-	-	158,570
Mich.4/	-	-	64,995	64,995	-	-	-	64,995
Exported3/	-	2,572	-	2,572	-	-	-	-
Total	7,619	147,403	78,589	233,611	-	-	-	231,039
All species								
Minn.	625,504	13,939	-	639,443	-	59,794	59,794	699,237
Wisc.	267,474	811,323	441,484	1,520,281	54,674	290,748	345,422	1,865,703
Mich.	7,161	-	458,161	465,322	-	83,937	83,937	549,259
Exported3/	2,838	2,572	-	5,410	-	-	-	-
Total	902,977	827,834	899,645	2,630,456	54,674	434,479	489,153	3,114,199

1/ Vertical columns of figures under box heading "Production by states" present the amount of pulpwood cut in each state.

2/ Mostly western states.

3/ Pulpwood shipped to mills outside of region.

4/ Balsam poplar (balm-of-Gilead) in Minnesota; mostly dense hardwoods in other states.

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No. 559

Simple Measures Can Improve Wisconsin's Farm Woodlands

The Mixed Oak Type

Continuous harvests of forest products can be obtained for several decades from the better stocked mixed oak stands in Wisconsin by following judicious cutting practices and protecting these areas from fire and livestock. Often, too, the volume of such woodlands can be increased and the quality improved while carrying on a program of this kind.

These conclusions are based on a 10-year summary of cutting records and sample-plot growth data for the Dundee Timber Harvest Forest in Fond du Lac County, east-central Wisconsin. Because of the similarity between the mixed oak stands on the 64-acre Dundee tract and those found elsewhere in the State, the results obtained from this case study can be applied, with slight modifications to meet individual situations and needs, to many hundreds of farm-owned woodlands throughout southern Wisconsin.

During the first 10-year cutting cycle, the average gross sawtimber volume of the Dundee tract increased from 5,327 to 6,451 board feet per acre (table 1). Trees that were saplings and small poles in 1947 and had grown to saw log dimension by 1957 added 333 board feet per acre to the stands. During the same period total cut was 1,039 board feet and mortality 89 board feet, so that the gross increment was actually 2,252 board feet per acre.

In terms of total board-foot volume, northern red oak comprises 61 percent of the 1947 stand; sugar maple, 17 percent; American and slippery elms, 6 percent; American basswood, 8 percent; and other hardwoods, 8 percent. Corresponding post-logging (1957) percentages were 65, 15, 7, 4, and 9 respectively.

Unmanaged woodlands almost always need to be "cleaned up" before an intensive program of silviculture can be undertaken. The Dundee Timber Harvest was no exception to this general rule. During the past 10 years, the entire 64-acre unit has been given an improvement cut which rogued out undesirable species, over-age and decadent trees, and poorly-formed stems. Approximately 45,000 board feet, net scale, of logs and box bolts, plus about 200 cords of rough wood, were obtained by six periodic logging operations. The gross receipts from this material were sufficient to charge off stumpage at prevailing prices, meet all out-of-pocket expenses, and pay labor at going rates.

Those landowners who have been inclined to believe that forestry practices are applicable only to large acreages of timber should be reassured by the past decade's results for the Dundee woods.

(over)

Table 1.--Gross sawtimber volumes and depletion per acre on the Dundee Timber Harvest Forest, 10-year period

(In board feet, Scribner Log Rule)

Species	Stand volume in 1947	10-year mortality	10-year cut	Stand volume in 1957
Northern red oak	3,252	41	438	4,183
Sugar maple	922	20	271	988
Slippery elm	328	28	14	453
American basswood	417	0	205	269
White ash	121	0	10	192
White oak	168	0	12	257
Red maple	38	0	20	27
Shagbark hickory	20	0	8	47
Paper birch	51	0	49	19
Bur oak	2	0	2	4
Aspen	8	0	10	0
American elm	0	0	0	2
Black cherry	0	0	0	10
Total	5,327	89	1,039	6,451

There is nothing out of the ordinary about this tract. It has about average productivity (site), and its per-acre volume in 1957 was only 60 percent of that possible under conditions of full stocking.1/ Obviously, then, what has been done there to increase the volume and improve the quality of the growing stock during the past 10 years could have been duplicated on scores of farms throughout southern Wisconsin.

Too many farmers wait too long to decide whether they wish to practice good forestry. In the meantime, either their woodlands are depleted to meet periodic financial needs or the stands deteriorate from natural causes (rots, insects, wind, grazing, etc.). Unfortunately, such indecisiveness has spelled the end of many fine woodlands in southern Wisconsin; it is much easier to maintain the productivity of mixed oak stands by proper management than to restore it after they have been seriously downgraded by neglect or abuse.

HAROLD F. SCHOLZ, Forester
Lake States Forest Experiment Station
FRED B. TRENK, Extension Forester
University of Wisconsin

July 1959

1/ Gevorkiantz, S. R., and Scholz, H. F. Timber yields and possible returns from the mixed oak farmwoods of southwestern Wisconsin. 72 pp., illus. 1948.

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LAKE STATES FOREST EXPERIMENT STATION
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No. 560

Heavy Thinning Increases Tree Size and Yield in an Upper Michigan Northern Hardwood Pole Stand

Studies in several timber types have shown that light thinnings do not appreciably change the total volume growth per acre but rather reduce the number of trees on which it occurs. These thinnings usually remove the low-quality and poor-risk trees. Similar results recently were observed 9 years after heavy thinning in a pole stand of northern hardwoods. Shortly after cutting by the farm owner, study plots were established. Similar plots were installed in a nearly comparable adjacent unthinned stand. These even-aged stands had developed after a commercial clear cut in 1921. Trees up to 13 inches in diameter at breast height were present, and the average stand diameter (of trees 3 inches and larger) was 4.5 inches. The composition was primarily sugar maple with some elm and ironwood (eastern hophornbeam). Other minor species were cherry, yellow birch, aspen, and basswood.

This thinning, 25 years after clear cutting, left the residual trees uniformly spaced over the area. Approximately 6½ cords per acre of chemical wood and fuelwood were removed by utilizing products to a 2-inch top. This cut removed 33 percent of the basal area and 32 percent of the cubic volume.

Although the annual net increase in volume per acre in the thinned stand is only slightly greater than in the unthinned stand (table 1 on back of sheet), it is accumulating on fewer and larger trees. In 9 years, the average diameter in the unthinned stand has increased only 1.0 inch compared to an increase of 1.5 inches in the thinned stand. In the unthinned stand the increase in basal area was less but height growth was greater so that the increase in volume was nearly the same on both areas.

Besides concentrating the growth on fewer trees per acre, this thinning also utilized many trees that otherwise might have been lost as mortality. The residual stand will yield larger products in a shorter period due to increased individual tree growth. Other studies have indicated that heavy cuttings may reduce individual tree quality. In this study no measure of tree quality is available, but early crown closure is believed to have minimized any losses in quality due to epicormic branching. To ensure an early crown closure, a sufficient number of trees should be left uniformly spaced over the area. Even in this heavy thinning there was a need to leave trees that were not of final crop-tree quality.

JOHN W. BENZIE
ROBERT L. CROSS
Research Foresters

July 1959

Table 1.--Comparison of young thinned and unthinned northern hardwood stands immediately after cutting and 9 years later; trees 3 inches d.b.h. and larger per acre

Treatment and year	Trees	Average diameter	Basal area	Volume	
	Number	Inches	Sq. ft.	Cu. ft.	Cords
Unthinned:					
1946	787	4.9	101	1,842	26
1955	697	5.9	132	3,085	44
Net change:					
In 9 years	-90	1.0	31	1,243	18
Ave./year	-10	.11	3.4	138	2.0
Thinned:					
1946	381	4.7	46	859	12
1955	436	6.2	93	2,165	31
Net change:					
In 9 years	55	1.5	47	1,306	19
Ave./year	6	.17	5.2	145	2.1

TECHNICAL NOTES

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No. 561

Sugar Maple and Yellow Birch Seed Dispersal from a Fully Stocked Stand of Mature Northern Hardwoods in the Upper Peninsula of Michigan

The dispersal of seed from sugar maple and yellow birch trees at the Upper Peninsula Experimental Forest indicates that an adequate amount of seed can be expected for at least 5 chains in all directions from an old-growth stand of northern hardwoods during good seed years. Sugar maple seed is nearly all on the ground before snowfall but most of the yellow birch seed falls on the snow in this area.

These results were obtained in a study on a 10-acre clear-cutting area where distances and time of dispersal could be measured. The distances measured from the edge of the timber are somewhat conservative for estimating seed travel, as part of the seed undoubtedly came from within the stand.

Seed traps were installed at 1-chain intervals in a north-south row and east-west row across the center of the clearing. Weekly collections of seed were made until snowfall in the middle of November, and a final collection was made after snowmelt in the spring.

This study was carried out during a good seed year for both sugar maple and yellow birch. Sugar maple averaged 290,000 seeds per acre at the edge of the uncut stand and 70,000 at the center of the clear-cut area. Yellow birch ranged from an average of 1,330,000 seeds per acre at the edge to 220,000 at the center.

Maximum seed dispersal for sugar maple occurred during the last 2 weeks of September when over one-half of the seed fell. An additional 30 percent fell during the first 2 weeks of October and by the 23d, over 90 percent of the sugar maple seed was on the ground. More than 99 percent of the sugar maple seed had fallen before the snow on November 13. Less than 6 percent of the yellow birch seed had fallen by October 23, and on November 13 only 12 percent had fallen. Eighty-eight percent of the yellow birch seed was dispersed over the winter.

Seed fall varied with the direction and distance from the seed source. The amount of sugar maple seed was the greatest from the south and east, but that of yellow birch was more numerous from the north. This is partly accounted for by the composition of the seeding stand. The northern hardwood type surrounds the area, but there is more yellow birch to the north and west than to the south and east where the stand is predominantly sugar maple.

Although the wind, at the time seeds were released, must have influenced the direction of seed fall, the prevailing winds could not be correlated to seed dispersal. This indicates that seeds are released intermittently rather than uniformly over the dispersal period. Factors other than wind are probably involved in determining the actual time seeds are dispersed after they ripen, but strong winds are expected to have considerable influence.

July 1959

JOHN W. BENZIE, Research Forester

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TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
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No. 562

Commercial Forest Land in Wisconsin Counties by Forest Type

Seventy percent of the commercial forest land in Wisconsin supports hardwood stands. The conifer types occupy about 13 percent. The remaining 17 percent is nonstocked.

Aspen is the most extensive forest type in Wisconsin, including three-tenths of the State's commercial forest land. The counties of Ashland, Bayfield, Douglas, Marinette, Oneida, Price, Sawyer, and Vilas each have over 200,000 acres of aspen. Northern hardwoods comprise the second largest type, occurring on one-sixth of the commercial forest land. Ashland, Forest, Langlade, Sawyer, and Shawano Counties each have more than 150,000 acres of northern hardwood. "Other hardwoods," occupying almost one-fourth of the total commercial forest land, are largely oak types and swamp and bottomland hardwoods.

There are 2,055,000 acres of coniferous stands, mostly in northern counties. Pine forests cover 1,014,000 acres.

These figures are results of a cooperative survey made from 1950-58 by the Wisconsin Conservation Department, the U. S. Forest Service, and other public agencies. Forest industries and northern counties helped finance the survey. Additional information about the timber resources of Wisconsin is available from the Wisconsin Conservation Department and the Lake States Forest Experiment Station.

The total commercial forest land is subject to a sampling error of ± 1.3 percent (1 standard deviation) per million acres. The sampling error for any type or county would be greater. Very small figures may be considerably in error but do indicate relative size.

(In thousands of acres)

County	Total commercial forest land area1/	Forest types2/							
		White and red pine3/	Jack pine 4/	Spruce and fir-spruce 5/	Other conifers 6/	Northern hardwoods 7/	Aspen 8/	Other hardwoods 9/	Non-stocked 10/
Adams	247	6	66	-	1	-	15	111	48
Ashland	554	9	1	53	21	154	212	37	67
Barron	152	5	1	2	1	33	42	45	23
Bayfield	793	21	59	16	7	122	432	73	63
Brown	46	2	*	-	2	16	4	13	9
Buffalo	188	1	-	-	-	4	20	146	17
Burnett	360	4	67	4	5	11	83	108	78
Calumet	24	*	-	-	1	6	1	11	5
Chippewa	245	2	1	2	6	22	88	85	39
Clark	293	5	4	2	1	31	151	62	37
Columbia	120	1	1	1	3	4	10	52	48
Crawford	183	-	-	-	*	21	9	112	41
Dane	68	1	*	*	*	2	4	51	10
Dodge	31	-	-	-	1	7	1	11	11
Door	104	3	-	4	11	33	25	17	11
Douglas	681	4	66	26	7	34	295	75	174
Dunn	165	5	3	*	-	22	15	93	27
Eau Claire	165	4	22	-	*	*	38	72	29
Florence	271	5	6	29	7	78	111	8	27
Fond du Lac	33	1	-	*	2	5	*	12	13
Forest	565	10	2	90	15	197	185	6	60
Grant	201	4	*	*	1	21	4	134	37
Green	26	*	*	*	-	9	1	12	4
Green Lake	26	1	-	-	1	1	*	18	5
Iowa	125	1	-	*	1	6	7	84	26
Iron	413	4	1	49	19	141	131	26	42
Jackson	325	12	73	2	6	-	57	144	31
Jefferson	33	1	*	*	*	9	1	12	10
Juneau	286	8	61	*	1	1	43	107	65
Kenosha	11	-	-	*	-	-	-	4	7

(Footnotes and continuation of table on back of sheet.)

HARRY W. THORNE, Forester
Wisconsin Conservation Department

ROBERT N. STONE, Forester
Lake States Forest Experiment Station

JULY 1959

(In thousands of acres)

County	Total commercial forest land area1/	Forest types2/: White and red pine3/	Jack pine 4/	Spruce and fir-spruce 5/	Other conifers 6/	Northern hardwoods 7/	Aspen 8/	Other hardwoods 9/	Non-stocked 10/
Kewaunee	37	*	-	-	6	10	8	8	5
La Crosse	122	2	1	-	-	8	17	81	13
Lafayette	36	*	-	-	-	4	4	14	14
Langlade	385	4	1	37	13	157	121	10	42
Lincoln	399	9	2	25	8	106	155	19	75
Manitowoc	62	5	-	-	6	19	4	18	10
Marathon	358	2	4	4	10	142	100	32	64
Marinette	652	12	35	22	36	52	255	126	114
Marquette	86	2	2	*	5	-	3	55	19
Milwaukee	5	*	-	*	-	1	-	2	2
Monroe	254	6	25	*	1	6	28	156	32
Oconto	428	16	21	17	22	50	171	71	60
Oneida	581	20	24	102	21	46	252	15	101
Outagamie	67	*	-	-	2	8	18	20	19
Ozaukee	19	*	-	-	3	9	-	4	3
Pepin	49	1	-	-	-	6	4	32	6
Pierce	90	*	-	*	-	33	5	34	18
Polk	243	5	19	1	6	32	63	79	38
Portage	151	6	11	-	6	4	24	66	34
Price	639	10	2	56	15	137	231	28	160
Racine	16	*	-	*	2	2	1	9	2
Richland	128	*	*	-	-	45	9	48	26
Rock	25	*	-	*	-	-	-	19	6
Rusk	361	1	-	3	7	116	149	29	56
St. Croix	68	*	-	*	-	10	11	28	19
Sauk	179	5	2	*	*	23	14	104	31
Sawyer	672	15	3	24	16	167	307	40	100
Shawano	404	20	1	5	41	165	69	55	48
Sheboygan	56	2	-	*	3	13	2	19	17
Taylor	355	3	-	15	6	125	113	38	55
Trempealeau	119	1	1	*	-	3	15	84	15
Vernon	178	-	-	-	-	38	12	101	27
Vilas	473	27	30	30	16	70	221	8	71
Walworth	34	*	-	*	*	2	2	14	16
Washburn	370	4	50	8	9	28	160	71	40
Washington	40	*	-	-	3	12	2	14	9
Waukesha	39	4	*	1	1	5	2	16	10
Waupaca	148	8	*	1	16	12	19	67	25
Waushara	131	5	2	*	6	1	5	74	38
Winnebago	17	*	-	-	1	1	2	7	6
Wood	186	7	22	2	1	5	48	58	43
Total	15,396	322	692	633	408	2,663	4,611	3,514	2,553

1/ Forest land which is producing or capable of producing operable crops of sawtimber, pulpwood, or products of comparable size and value within 100 years and is not withdrawn from timber utilization. Forest tract of less than 1 acre, and isolated strips of timber less than 120 feet wide are excluded.

2/ Forest type is based on the predominance of the key species.

3/ Pine species predominating with red and white pine most common.

4/ Pine species predominating with jack pine most common.

5/ Conifer species predominating with white spruce and balsam fir, or black spruce most common.

6/ Other conifers include tamarack and cedar types.

7/ Sugar maple, yellow birch, and beech predominating.

8/ Aspen and paper birch predominating.

9/ Other hardwoods include swamp and bottomland hardwoods, oak, and cottonwood types.

10/ Lands qualifying as forest but failing to meet specifications for sawtimber, poletimber, or restocking stands. Includes grass and brush areas.

* Less than 500 acres.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 563

Sawtimber Log Grades in Wisconsin

Log grades are a measure of sawtimber quality and value. The grade distribution of the sawtimber resource in an area indicates the type of industry it can support now and in the near future.

A special study made in 1953 provided log grade data for northwestern, northeastern, and central Wisconsin. Information for southern Wisconsin was taken during the regular forest survey in 1956 and 1957. These data are the result of a cooperative effort by the Lake States Forest Experiment Station, the Wisconsin Conservation Department, and others participating in the Wisconsin Forest Inventory. The sample consisted of 1,112 trees. This was sufficient to provide usable proportions of volume by log grade for 10 major species (table 1).

Table 1.--Percent of merchantable volume in each log grade, by major species, Wisconsin

Species	Volume in sample, bd. ft.	Percent by log grades[1/]			
		No. 1	No. 2	No. 3	Tie & timber
Conifers					
White pine	6,300	36	33	31	-
Red pine	4,300	20	26	54	-
Hardwoods					
Sugar maple	22,900	22	21	36	21
Basswood	17,400	19	23	36	22
American elm	10,500	24	30	27	19
Slippery elm	7,200	18	38	30	14
Red oak	43,800	10	20	35	35
Black oak	4,600	7	11	12	70
White oak	11,800	5	11	40	44
Ash	6,800	7	35	41	17

1/ For specifications see: Hardwoods--Hardwood Log Grades for Standard Lumber, U. S. Forest Prod. Lab. Rpt. D-1737, 60 pp., Madison, Wis., 1953; and Interim Specifications for Ties, Timbers, or Construction Material (unpublished), U. S. Forest Serv., Wash., D.C., 1948. Softwoods--Official Grading Rules for Northern Hardwood and Softwood Logs, Northern Hemlock and Hardwood Mfrs. Assoc., 12 pp., Oshkosh, Wis., 1943 (softwood log grades of Prime, No. 1, and No. 2 correspond to log grades No. 1, No. 2 and No. 3 above respectively).

The way log grades affect yields of high-quality (and high-value) lumber can best be shown by example. For red oak the proportion of No. 1 common or better lumber that can be sawn from a grade 1 log is about 70 percent, from a grade 2 log about 44 percent, and from a grade 3 log about 21 percent.

ROBERT N. STONE, Research Forester
CLARENCE D. CHASE, Research Forester
Lake States Forest Experiment Station

JULY 1959

(Over)

A grade 2 red oak log is worth roughly three-fourths as much as a grade 1 red oak log with the same dimensions; a grade 3 log is worth about half as much as a grade 1 log.1/

The proportion of merchantable volume in the two top grades provides a means of comparing timber quality of several species by survey districts (table 2). Quality of the pines is best in the north. Quality of the hardwood species varies but for most of the species shown is best in northeastern Wisconsin.

The effect of tree size on log grade is illustrated by sugar maple. Over two-thirds of the sawtimber volume of this species in Wisconsin is in trees 16 inches and larger at breast height (table 3). Ninety-six percent of grade 1 logs and 70 percent of grade 2 logs were in these larger trees. Low grades predominate in the 12- to 14-inch diameter classes; high grades in the larger size trees.

1/ Hardwood log grades for standard lumber, U. S. Forest Prod. Lab. Rpt. D-1737, 60 pp., Madison, Wis., 1953.

Table 2.--Proportions of merchantable volume in grades 1 and 2 logs in Wisconsin by major species and survey districts

Species	Percent of merchantable volume in grades 1 and 2 logs				
	Entire state	North-western Wisconsin	North-eastern Wisconsin	Central Wisconsin	Southern Wisconsin
Conifers					
White pine	69	77	71	52	(1/)
Red pine	46	52	45	39	(1/)
Hardwoods					
Sugar maple	43	18	61	54	25
Basswood	42	26	50	52	35
American elm	54	61	36	75	36
Slippery elm	57	(1/)	67	(1/)	42
Red oak	30	24	58	34	26
White oak	16	-	42	13	17
Ash	42	72	37	30	31

1/ Sample too small to be representative.

Table 3.--Distribution of sugar maple sawtimber by log grades in three diameter groups, Wisconsin

(In percent)

D.b.h. classes (inches)	Log grades				
	All grades	No. 1	No. 2	No. 3	Tie & timber
	Distribution within log grade				
12-14	28	4	30	35	38
16-18	55	68	46	54	53
20+	17	28	24	11	9
Total	100	100	100	100	100
	Distribution within diameter group				
12-14	100	3	23	46	28
16-18	100	27	18	35	20
20+	100	36	29	24	11
All trees	100	22	21	36	21

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 564

Pattern of Soil Moisture Depletion Varies Between Red Pine and Oak Stands in Michigan[1/]

The conversion of low-value scrub oak to pine plantations is a common forest management practice on deep sand soils in northern Lower Michigan. The value of timber produced over the same period is much greater from these plantations than from the scrub oak type. This conversion has been found to cause no major change in total soil moisture utilization, according to studies under way by the Station in cooperation with the Michigan Department of Conservation. The change is largely in seasonal use.

The moisture contents of the sandy soils under two densely stocked red pine plantations about 25 years old and two natural oak stands 60-70 years old were sampled at monthly intervals from April through October 1958. Four samples from depths of 0-1, 1-2, 2-3, 3-5, and 5-7 feet were taken on each sampling date on 1-acre plots. Bulk density measurements and 15 atmosphere wilting percentage values were utilized to convert the percent moisture content by weight to inches of available moisture.

The difference in pattern and rate of soil moisture depletion between the two cover types is illustrated in figure 1. Soil moisture levels in both forest types were at field capacity at the beginning of the growing season. The red pine stands started using soil moisture in April and May. Soil moisture levels were lowered under this cover type at a relatively uniform rate until the moisture reserves in the rooting zone were nearly exhausted by late July and early August.

Soil moisture utilization was slow under the oak stands until full-leaf development was reached in June. Heavy rains the first week of July restored soil moisture levels to nearly field capacity although rapid moisture utilization doubtless had commenced prior to this time. During the remainder of July the rate of moisture depletion was very rapid under the oak and the moisture reserves reached the same low level as those under pine stands by August 1. At the end of the sampling period in mid-October, soil moisture had recharged to the same levels in both oak and pine areas.

The most obvious contrast in soil moisture use between red pine and oak is the early season differences in depletion patterns. Considering the entire growing season as a whole, both forest types ultimately utilize most of the stored soil moisture on sandy soils; and there is no major difference in total soil moisture utilization between these two forest types.

July 1959

DEAN H. URIE, Research Forester

1/ This study is one phase of a watershed research project being conducted in cooperation with the Michigan Department of Conservation.

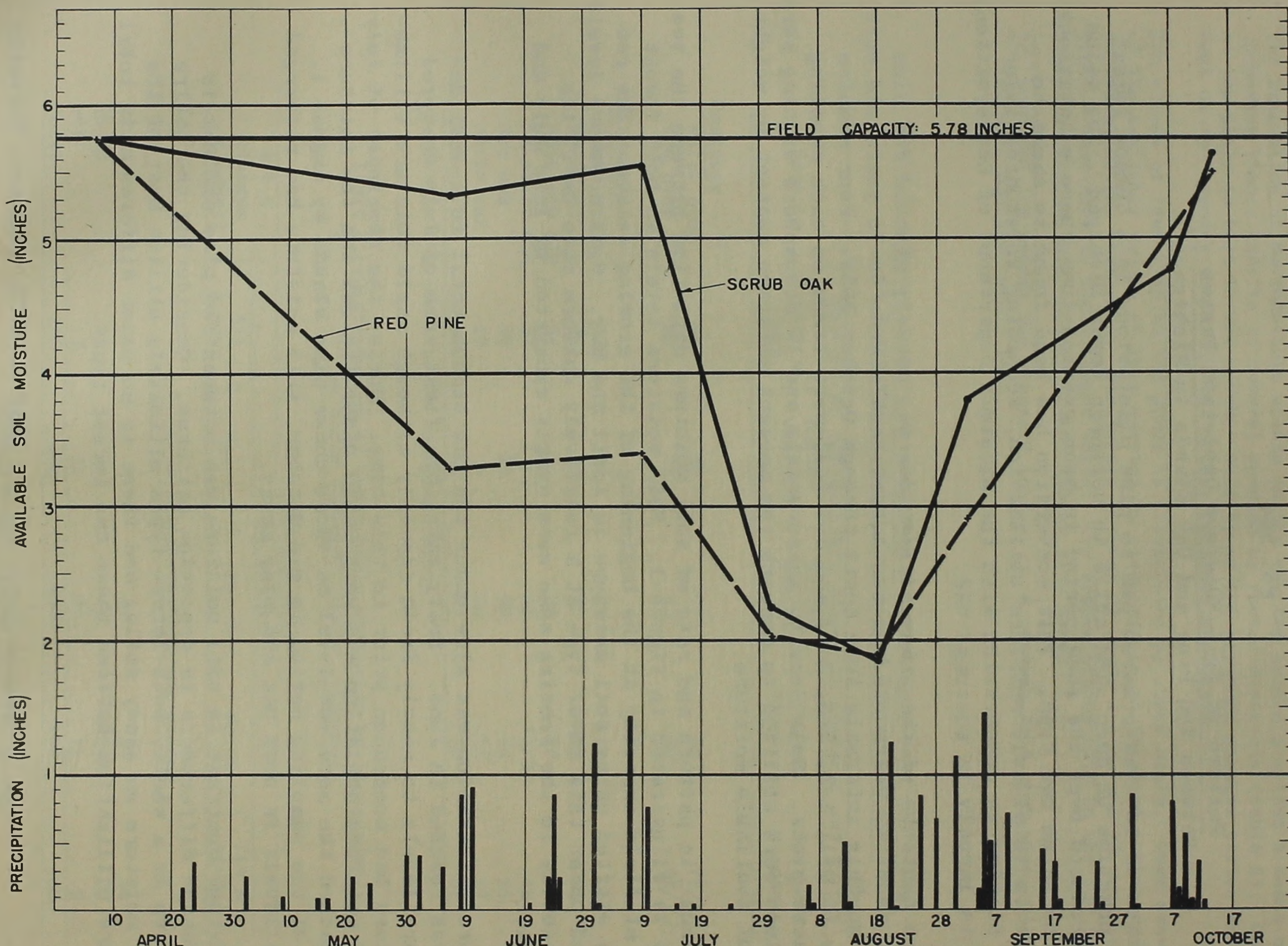


Figure 1.--Pattern of soil moisture depletion and recharge under red pine and oak stands, 1958. Measurements were made in top 7 feet of soil.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 565

1958 Forest Tree Seed Crop Poor in the Lake States

During 1958 forest tree seed crops in general were poorer than any year except 1949 for the 13-year period since 1946, according to observations made at field centers of the Lake States Forest Experiment Station. Despite general low seed production some species in northeastern Wisconsin and Upper Michigan had good or bumper crops (see table on reverse side). Seed crops of most tree species varied by localities from failing to fair. In comparison with 1957, seed production was generally better in the Upper Peninsula, about the same in northeastern Wisconsin, and much poorer in northern Minnesota and Lower Michigan.

In northern Minnesota good crops were reported for some localities for jack pine, black spruce, and northern white-cedar. Seed crop failures occurred in one or more localities for the following species: Red pine, eastern white pine, white spruce, balsam fir, northern white-cedar (varied from failure to good), tamarack, sugar maple, basswood, paper birch, quaking aspen, balsam poplar, black ash, bur oak, and northern red oak.

Bumper crops were produced in some localities of northeastern Wisconsin by northern white-cedar, balsam fir, and eastern hemlock. Good crops were reported for black spruce, sugar maple, basswood, yellow birch, paper birch, quaking aspen, bigtooth aspen, American elm, and white ash. Only Norway spruce had a crop failure.

In central Upper Michigan balsam fir, eastern hemlock, and yellow birch had bumper seed crops; black spruce and American beech produced good crops. Crop failures were reported for eastern white pine, basswood, American elm, and black ash.

In some localities of Lower Michigan northern red oak had a good seed crop and American beech had a fair crop. All other species reported had poor seed crops or failures. This is in contrast to generally good crops last year.

Good seed crops for chokecherry and Russian-olive were reported from north central North Dakota. Except for caragana (poor) and American plum (fair) all other species had seed crop failures.

Since most seed collectors are interested in the pines, 1958 will be considered a poor seed year in the Lake States. Wildlife species that depend largely on mast for winter food had generally poor prospects where oaks occur but somewhat better ones where beech is the main food.

July 1959 PAUL O. RUDOLF, Research Forester

... IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--Forest tree seed crops in the Lake States, 1958

Species	Estimated percentage of a full crop[1] in --				
	Northern Minnesota	Northeastern Wisconsin	Central Upper Michigan	Lower Peninsula Michigan	North central North Dakota
Red pine	7-25	7-25	50	[2] 7	[3] -
Eastern white pine	7-25	25-50	7	7	-
Jack pine	25-75	50	50	-	-
Ponderosa pine	-	-	-	-	7
White spruce	7-25	25-50	50	[2] 7	-
Black spruce	50-75	50-75	75	-	-
Norway spruce	-	7	-	-	-
Balsam fir	7-50	75-95	95	-	-
Eastern hemlock	-	75-95	95	-	-
Northern white-cedar	7-75	95	25	-	-
Tamarack	7	7-25	-	-	-
Sugar maple	7-50	75	25	-	-
Red maple	-	-	25	-	-
Boxelder	-	-	-	-	7
American beech	-	-	75	25-50	-
Basswood	7	75	7	-	-
Yellow birch	50	50-75	95	-	-
Paper birch	7-25	50-75	50	-	-
Quaking aspen	7-25	75	-	-	-
Bigtooth aspen	-	75	-	-	-
Balsam poplar	7	-	-	-	-
American elm	-	75	7	-	7
Siberian elm	-	-	-	-	7
Hackberry	-	-	-	-	7
White ash	-	50-75	-	-	-
Green ash	-	-	-	-	7
Black ash	7	25-50	7	-	-
Bur oak	7	-	-	-	7
Northern pin oak	-	-	-	[2] 7	-
Black oak	-	-	-	25	-
Northern red oak	7	25	50	25-75	-
White oak	-	25	-	7	-
Chokecherry	-	-	-	-	75
American plum	-	-	-	-	50
Russian-olive	-	-	-	-	75
Caragana	-	-	-	-	25

1/ Percentage of a full crop classified as 0-15, failure; 16-35, poor; 36-60, fair; 61-90, good; and 91-100, bumper.
2/ In the north half of the Lower Peninsula.
3/ A dash (-) signifies no report on this species.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 566

Air Seasoning of Wood Reduces Charcoal Production Time

Forty percent less time was required to carbonize air-seasoned sugar maple (*Acer saccharum* Marsh.) than green sugar maple in a series of burns carried out in northern Wisconsin. Average carbonization time was 20 hours for the green maple and 12 hours for the air-seasoned wood.

Six experimental burns were made in a 3-cord, cinder-concrete block kiln[1/] -- three with freshly cut hard maple and three with wood that had been air seasoned for 2 years in uncovered piles. Average moisture contents of the green and seasoned wood were 62.2 and 35.3 percent, respectively.

Each kiln charge consisted of 4-foot rough roundwood, about 6 inches average diameter, piled in two 6-foot-high tiers on 7-inch stringers. Ignition was from a combustion chamber at the geometric center of the floor; draft was through 4 stacks, one at each kiln corner. Average charcoal yields, based on ovendry weight of the kiln charges, were 26.4 percent for the green maple and 29.3 percent for the seasoned material.

Average hourly kiln temperatures (fig. 1) were measured by evenly spaced thermocouples in the kiln ceiling, midway between the ceiling and kiln floor, and 12 inches above kiln floor. All temperatures were controlled by regulating the volume of air supplied to the combustion chamber through a 6-inch pipe by a centrifugal fan.

As each burn progressed, the air intake was periodically reduced just enough to keep average ceiling temperatures under 1000° F. and allow the lower load temperatures to build up to 800° F. Previous tests indicated that for good charcoal yields average temperatures within the bottom of the charge have to be maintained at or above 800° F. at least 8 hours for green maple and at least 4 hours for air-seasoned maple. When the required temperature conditions were satisfied, the air intake was closed and the kiln sealed.

More heat is needed to carbonize green wood than air-seasoned wood (fig. 1). This is because more water must be removed before carbonization is possible. Because of the characteristics of wood carbonization and the temperature limitations within the cinder-concrete block kiln, it is necessary to extend the cycle time rather than increase the average hourly kiln temperatures.

July 1959

JAMES C. WARD, Technologist

1/ Lane, Paul H. Design of a cinder-concrete block charcoal kiln. U. S. Forest Serv., Lake States Forest Expt. Sta. Tech. Note 494, 2 pp., illus. (Processed.) 1957.

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

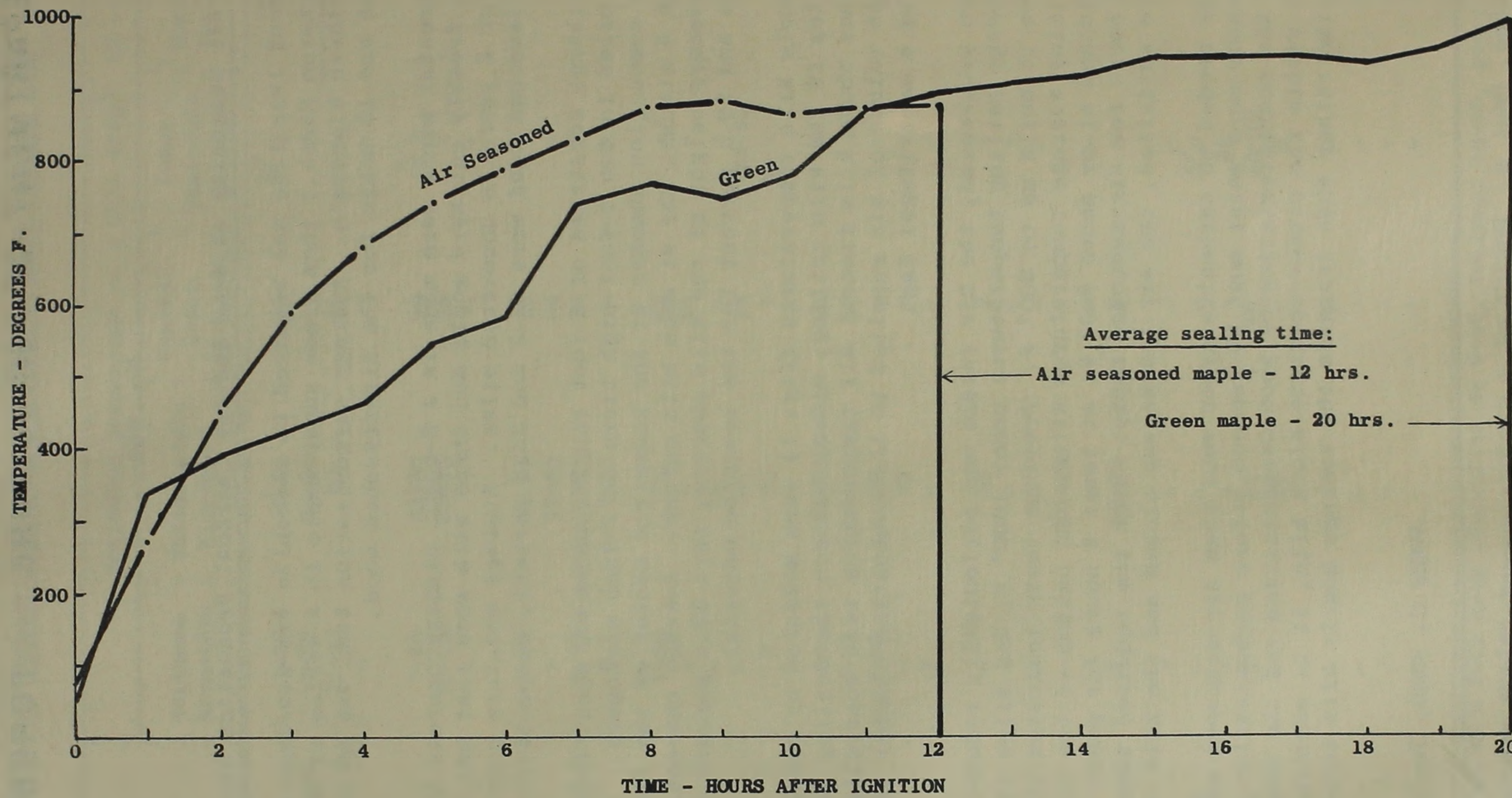


Figure 1.--Comparison of average charcoal kiln temperatures for air-seasoned and green sugar maple based on three burns each.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 567

Veneer Log Production Declines Sharply in Lake States as Result of Mill Closures, 1958

A recent survey completed by the Station shows that veneer log production in the Lake States amounted to approximately 53 million board feet in 1958 (see table on reverse side). This cut is one-third less than in 1956 and is the smallest recorded since the mid-thirties. Of the three states, Michigan showed the greatest decline in production, decreasing 50 percent from 1956. The decline in Wisconsin was only 22 percent. Minnesota production, on the other hand, registered a slight increase.

Fifteen of the 90 veneer mills in the region have closed down operations since the mid-fifties. Twelve of these were container veneer plants using about 15 million board feet of container grade logs; and the other three produced commercial, utility, and special type veneer from about 5 million board feet of high-grade veneer logs. Most of the plants active in 1958 did not maintain their usual levels of operation. The mill closures, as well as the lower production of the active plants, were caused mainly by uncertain business conditions, stiff competition from other areas and products, and a short supply of quality veneer timber.

Total veneer log receipts at Lake States mills were about 57½ million board feet, a decline of 38 percent from 1956. Beech, maple, and birch declined the most, dropping off by 68, 56, and 40 percent, respectively. Imports from other states and Canada declined 73 and 49 percent, respectively. Standard grade veneer plants received approximately 44½ million board feet of the total; the remaining 13 million board feet were channeled to plants producing container veneers. In addition container plants received 11,000 cords of bolts for producing heading stock.

Geographic origin and destination of veneer logs received by Lake States plants, 1958

Species	Percent of veneer logs originating from:					Percent of veneer logs received by:		
	Minn.	Wis.	Mich.	Other U. S.	Canada	Minn. mills	Wis. mills	Mich. mills
Aspen	14	83	3	-	-	2	96	2
Ash	17	66	17	-	-	5	89	6
Basswood	39	43	15	3	-	17	71	12
Beech	-	4	96	-	-	-	6	94
Birch	8	17	51	-	24	-	73	27
Cottonwood	86	2	12	-	-	15	73	12
Elm	19	57	21	3	-	2	78	20
Maple, hard	2	47	43	-	8	-	75	25
Maple, soft	4	52	34	10	-	1	71	28
Oak	12	77	7	2	2	-	98	2
Walnut	-	73	27	-	-	-	-	-
Misc. hardwoods	6	39	44	9	2	-	68	32
All species	15	40	34	2	9	3	75	22
Previous survey (1956)	10	33	43	3	11	2	73	25

A. G. Horn
Forest Economist

JULY 1959

... IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Production and imports of veneer logs, Lake States, 1958
(M board feet International 1/4-Inch Log Rule)

Species and destination	Production by states 1/				Imports			Total receipts
	Minnesota	Wisconsin	Michigan	Region	Other U. S. 2/	Canada	Total imports	
Aspen								
Minnesota	26	-	-	26	-	-	-	26
Wisconsin	210	1,443	28	1,681	-	-	-	1,681
Michigan	-	-	28	28	-	-	-	28
Total	236	1,443	56	1,735	-	-	-	1,735
Ash								
Minnesota	28	-	-	28	-	-	-	28
Wisconsin	68	384	67	519	-	-	-	519
Michigan	-	-	34	34	-	-	-	34
Total	96	384	101	581	-	-	-	581
Basswood								
Minnesota	1,245	-	-	1,245	-	-	-	1,245
Wisconsin	1,520	3,137	292	4,949	253	1	254	5,203
Michigan	72	-	804	876	-	-	-	876
Total	2,837	3,137	1,096	7,070	253	1	254	7,324
Beech								
Minnesota	-	-	-	-	-	-	-	-
Wisconsin	-	70	46	116	-	-	-	116
Michigan	-	-	1,714	1,714	-	-	-	1,714
Total	-	70	1,760	1,830	-	-	-	1,830
Birch								
Minnesota	55	-	-	55	-	-	-	55
Wisconsin	1,155	2,968	5,663	9,786	-	2,776	2,776	12,562
Michigan	94	-	3,176	3,270	-	1,319	1,319	4,589
Total	1,304	2,968	8,839	13,111	-	4,095	4,095	17,206
Cottonwood								
Minnesota	325	-	-	325	-	-	-	325
Wisconsin	1,547	31	-	1,578	-	-	-	1,578
Michigan	-	-	264	264	-	-	-	264
Total	1,872	31	264	2,167	-	-	-	2,167
Elm								
Minnesota	138	-	-	138	-	-	-	138
Wisconsin	1,567	5,272	57	6,896	293	-	293	7,189
Michigan	-	-	1,828	1,828	-	4	4	1,832
Total	1,705	5,272	1,885	8,862	293	4	297	9,159
Maple, hard								
Minnesota	-	-	-	-	-	-	-	-
Wisconsin	250	4,886	1,367	6,503	25	688	713	7,216
Michigan	-	-	2,164	2,164	-	188	188	2,352
Exported 3/	-	-	974	974	-	-	-	-
Total	250	4,886	4,505	9,641	25	876	901	9,568
Maple, soft								
Minnesota	19	-	-	19	-	-	-	19
Wisconsin	78	1,302	157	1,537	242	3	245	1,782
Michigan	-	-	684	684	-	4	4	688
Total	97	1,302	841	2,240	242	7	249	2,489
Oak								
Minnesota	-	-	-	-	-	-	-	-
Wisconsin	606	3,814	309	4,729	103	86	189	4,918
Michigan	-	80	-	80	-	-	-	80
Exported 3/	-	-	36	36	-	-	-	-
Total	606	3,894	345	4,845	103	86	189	4,998
Walnut								
Minnesota	-	-	-	-	-	-	-	-
Wisconsin	-	-	-	-	-	-	-	-
Michigan	-	-	-	-	-	-	-	-
Exported 3/	-	172	65	237	-	-	-	-
Total	-	172	65	237	-	-	-	-
Misc. species								
Minnesota	2	-	-	2	-	-	-	2
Wisconsin	26	181	92	299	-	-	-	299
Michigan	-	-	89	89	40	11	51	140
Exported 3/	-	-	20	20	-	-	-	-
Total	28	181	201	410	40	11	51	441
All species								
Minnesota	1,838	-	-	1,838	-	-	-	1,838
Wisconsin	7,027	23,488	8,078	38,593	916	3,554	4,470	43,063
Michigan	166	80	10,785	11,031	40	1,526	1,566	12,597
Exported 3/	-	172	1,095	1,267	-	-	-	-
Total	9,031	23,740	19,958	52,729	956	5,080	6,036	57,498

1/ Vertical columns of figures under box heading "Production by states" represents the quantity of veneer logs cut in each state.

2/ Central and western states.

3/ Veneer logs shipped to mills outside Lake States region.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 568

Defect in Wisconsin Timber

Defect of merchantable trees in Wisconsin averages 2½ to 3 times as high for the saw-log portion of sawtimber-size trees as for poletimber trees. Expressed as a percent of gross volume, the State average defect ranges from 1 to 6 percent for poletimber and from 6 to 17 percent for sawtimber (table 1).

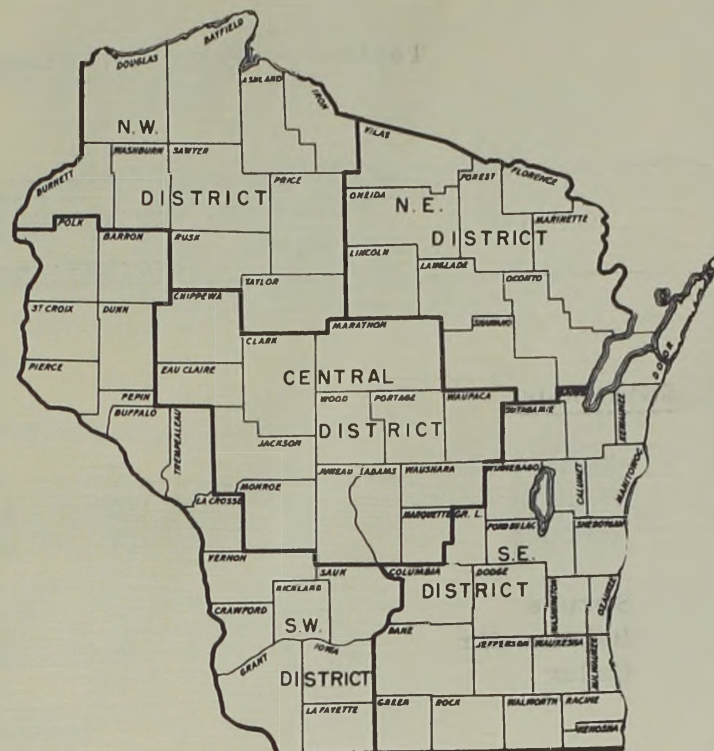


Figure 1.--Wisconsin Forest Survey Districts.

During the second timber inventory of Wisconsin, defect from all causes was observed in trees on 13,665 one-fifth acre survey plots which were well scattered throughout the State's commercial timberland.[1/] Estimates, based on observations of external defect indicators, were made for all live merchantable trees. Defect in cull trees (trees 60 percent or more unusable) was not included. Since the amount of a tree that is usable varies with the end product, it was assumed that poletimber-sized trees would be cut for pulpwood and that sawtimber trees would be bucked into saw logs.

Poletimber defect varied little by district, and averaged about 3 percent for the softwood species and about 5 percent for the hardwood species.

Sawtimber defect showed wide variations by district. The lowest defect was found in central Wisconsin, the highest in southeastern Wisconsin (figure 1). The low defect percent for sawtimber in central Wisconsin is correlated with low average diameters brought about by heavy cutting. In southern Wisconsin the high defect in sawtimber is associated with larger, older trees left after intermittent cutting of the better trees in farm woodlots. High grading and lack of cutting both accumulate defective trees. Heavy grazing, which encourages root and butt rot through bruises on roots and lower stems, is common in this district and has undoubtedly increased the defect.

Defect percents indicate the reduction of present merchantable volumes and the loss of new growth accruing on defective parts of trees.

1/ Conducted by the Wisconsin Conservation Department, the Lake States Forest Experiment Station, and certain counties and forest industries from 1950-57.

HARRY W. THORNE, Forester
Wisconsin Conservation Department

ROBERT N. STONE, Forester
Lake States Forest Experiment Station

October 1959

Table 1.--Defect in Wisconsin timber, 1956

Species	Poletimber trees	Sawtimber trees by district: State average	North-east	North-west	Central	South-east	South-west
		In Percent					
Softwoods							
White pine	3	7	8	7	4	12	8
Jack pine	2	6	10	4	5	8	5
Hemlock	4	11	11	14	-	-	-
Spruce	1	-	-	-	-	-	-
Balsam fir	3	-	-	-	-	-	-
Cedar	5	-	-	-	-	-	-
Hardwoods							
Aspen	6	14	14	13	9	25	19
Sugar maple	5	15	14	16	12	27	15
Soft maple	5	12	13	15	9	26	20
Yellow birch	5	15	14	18	13	21	15
Basswood	4	11	9	11	8	32	16
Elm	4	12	8	9	6	22	15
Red oak	4	14	19	12	8	23	14
Black oak	5	17	-	-	11	25	25
White oak	5	16	4	14	8	28	17
Ash	4	12	9	12	7	19	12
White birch	4	-	-	-	-	-	-

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 569

TIMBER VOLUME IN WISCONSIN COUNTIES

Wisconsin's commercial forest land supports nearly 98 million net cords of timber; 59 percent of this is in the two northern districts. Shawano County with 6,207,000 cords has more growing stock than any other county in the State. Bayfield and Forest Counties, next in order, each have between 4 and 5 million cords.

Soft hardwoods constitute 43 percent of the growing stock volume, hard hardwoods 39 percent, and conifers 18 percent. Nine-tenths of the conifer volume is in the northern and central districts. Soft hardwoods predominate in the northern two districts, and hard hardwoods in the remaining three districts.

Net sawtimber volume totals 16.3 billion board feet, three-fourths of it in hardwood species. Pine, hemlock, and sugar maple are the predominant sawlog species in the north; oaks and elms are the leading sources of sawlog volume in the central and southern districts.

Shawano County has more sawtimber than any other county in the Lake States; it has nearly 11 percent of Wisconsin's sawtimber supply.

The 1.7 billion board feet in Shawano, much of it in the Menominee Indian Reservation, is more than three times the volume in the next highest Wisconsin county.

Volume statistics for each county have been published by the Wisconsin Conservation Department in a series of Forest Inventory Reports. The volume information is repeated here in detail to facilitate its use. These statistics are part of the results of a cooperative Forest Survey conducted during 1950-58 by the Wisconsin Conservation Department and the U. S. Forest Service. Forest industries and 31 northern and central counties helped finance the survey.

The total net timber volume on commercial forest land is subject to a sampling error of ± 1.3 percent (1 standard deviation) per billion cubic feet. The sampling error for any species group, county, or district may be greater. Small figures can be considerably in error but do indicate relative size.

Volume of growing stock and sawtimber in Wisconsin by species, district, and county

(NOTE: Volumes of all conifer species are combined for the central and southern districts (next page), where they are less important than in the northern districts. The sawtimber volumes of red and white oaks, however, are shown separately in the central and southern districts where they make up about one-fourth of the board-foot volume. Yellow birch in these areas is combined with "other hardwoods.")

County	Growing stock[1/]							Sawtimber[2/]												
	Total	Pine	Spruce-fir	Tam. and cedar	Hemlock	Hard hdwd. 3/	Soft hdwd. 4/	Total	White & red pine	Hemlock	Other conifers	Sugar maple	Soft maple 5/	Ash	Basswood	Aspen	Elm	Oak	Yellow birch	Other hdwds.
	Thousand cords[6/]							Million bd. ft.[7/]												
NORTHWEST DISTRICT																				
Ashland	3,213	175	255	196	119	916	1,552	406	49	39	54	73	17	16	17	36	32	4	64	5
Bayfield	4,785	542	213	90	86	894	2,960	439	109	31	51	43	20	16	21	77	14	14	30	13
Burnett	1,377	366	15	28	-	481	487	142	27	-	18	7	2	11	8	11	14	42	1	1
Douglas	2,482	314	152	61	7	416	1,532	191	43	2	38	10	8	14	6	34	15	5	6	10
Iron	2,136	106	176	149	168	532	1,005	292	36	55	38	53	7	8	11	18	20	1	43	2
Price	3,239	139	181	126	177	783	1,833	386	45	56	28	56	31	15	20	40	35	7	46	7
Rusk	1,867	53	29	26	49	655	1,055	225	19	16	5	52	13	11	24	13	32	24	14	2
Sawyer	3,953	281	96	75	111	1,075	2,315	454	84	38	20	74	21	17	35	44	45	37	34	5
Taylor	2,296	70	59	37	179	746	1,205	310	24	57	9	42	26	27	20	16	43	15	27	4
Washburn	1,775	340	26	40	-	544	825	147	37	-	16	7	2	7	8	17	9	42	1	1
Total	27,123	2,386	1,202	828	896	6,942	14,869	2,992	473	294	277	417	147	142	170	306	259	191	266	50
NORTHEAST DISTRICT																				
Florence	2,330	145	123	138	253	626	1,045	465	29	94	38	105	9	10	38	19	59	10	35	19
Forest	4,015	181	442	284	259	1,036	1,813	548	29	90	56	173	7	6	22	37	43	4	64	17
Langlade	2,255	89	88	98	154	743	1,083	320	28	51	17	77	13	7	18	20	36	26	13	14
Lincoln	2,220	163	93	45	79	519	1,321	280	47	23	13	44	30	13	15	23	36	5	23	8
Marinette	3,630	365	209	236	121	737	1,962	457	74	38	70	23	18	15	12	46	62	51	11	37
Oconto	3,107	334	165	246	126	602	1,634	460	94	42	52	33	16	19	15	37	75	32	13	32
Oneida	3,067	581	220	113	110	419	1,624	325	134	36	36	23	7	7	4	32	1	9	23	13
Shawano	6,207	854	101	359	1,150	2,073	1,670	1,738	333	421	78	327	40	27	106	31	148	89	95	43
Vilas	3,326	629	125	62	173	519	1,818	404	141	60	31	43	9	3	7	42	1	13	34	20
Total	30,157	3,341	1,566	1,581	2,425	7,274	13,970	4,997	909	855	391	848	149	107	237	287	461	239	311	203

(Footnotes and continuation of table on back of sheet.)

(Over)

ROBERT N. STONE, Forester
Lake States Forest Experiment Station

HARRY W. THORNE, Forester
Wisconsin Conservation Department

OCTOBER 1959

County	Growing stock 1/				Sawtimber 2/										
	Total	Conifers	Hard hardwoods 3/	Soft hardwoods 4/	Total	Conifers	Sugar maple	Soft maple 5/	Ash	Basswood	Aspen	Elm	Red oak	White oak	Other hardwoods
	Thousand cords 6/				Million bd. ft. 7/										
							CENTRAL DISTRICT								
Adams	822	234	483	105	118	31	-	5	2	1	2	8	53	14	2
Chippewa	1,226	87	585	554	201	22	30	8	7	12	10	39	47	24	2
Clark	1,579	88	712	779	264	22	43	13	10	16	15	47	68	26	4
Eau Claire	587	66	341	180	80	13	3	3	2	2	3	9	30	14	1
Jackson	1,350	357	738	255	221	63	4	8	1	1	5	8	89	37	5
Juneau	1,054	241	591	222	187	43	7	10	1	2	3	11	71	31	8
Marathon	2,661	293	978	1,390	461	71	115	34	21	39	7	108	31	1	34
Marquette	450	39	346	65	98	7	1	3	1	1	1	3	61	19	1
Monroe	1,483	190	1,065	228	314	40	18	7	2	9	5	10	161	56	6
Portage	907	163	503	241	159	38	7	9	6	5	5	13	55	17	4
Waupaca	1,291	207	613	471	255	41	23	29	20	16	8	31	61	19	7
Waushara	577	68	381	128	106	13	2	5	4	2	2	10	49	17	2
Wood	768	141	345	282	149	28	14	10	5	10	2	21	40	15	4
Total	14,755	2,174	7,681	4,900	2,613	432	267	144	82	116	68	318	816	290	80
							SOUTHWEST DISTRICT								
Barron	1,256	97	608	551	238	35	23	3	7	24	10	37	67	24	8
Buffalo	2,046	19	1,443	584	486	5	14	22	7	17	25	39	271	68	18
Crawford	1,178	2	845	331	265	-	13	5	3	18	6	24	121	58	17
Dunn	1,391	89	817	485	298	32	20	13	7	25	11	39	104	36	11
Grant	1,552	18	1,143	391	358	5	18	11	6	22	7	29	169	69	22
Iowa	910	26	691	193	220	10	5	3	2	10	4	11	120	43	12
LaCrosse	1,117	28	758	331	282	10	8	13	5	15	6	19	143	45	18
LaFayette	177	-	128	49	40	-	1	-	-	3	1	4	18	10	3
Pepin	499	19	310	170	112	6	7	3	4	8	4	14	47	15	4
Pierce	876	12	507	357	216	4	26	8	6	23	9	38	77	18	7
Polk	1,760	167	833	760	277	37	21	5	13	28	11	39	79	32	12
Richland	910	2	549	359	186	-	26	6	4	23	4	25	61	26	11
Sauk	1,733	38	1,221	474	403	10	20	13	9	28	11	32	203	59	18
St. Croix	485	8	278	199	86	3	9	1	3	9	3	13	28	13	4
Trempealeau	1,062	19	737	306	210	5	4	8	5	8	8	16	114	34	8
Vernon	1,572	3	1,141	428	392	1	38	5	6	31	7	31	193	63	17
Total	18,524	547	12,009	5,968	4,069	163	253	119	87	292	127	410	1,815	613	190
							SOUTHEAST DISTRICT								
Brown	439	47	194	198	94	8	13	4	5	3	2	28	13	5	13
Calumet	197	16	82	99	49	3	5	1	3	2	1	19	3	6	6
Columbia	587	13	425	149	106	2	1	4	4	3	1	9	41	31	10
Dane	530	-	458	72	131	-	1	-	1	1	-	1	64	49	14
Dodge	231	5	131	95	64	1	4	6	7	7	-	11	14	10	4
Door	1,003	202	378	423	168	33	24	4	8	6	9	40	14	4	26
Fond du Lac	188	11	102	75	44	2	4	1	3	2	-	12	8	8	4
Green	254	-	192	62	63	-	5	1	5	4	-	5	25	13	5
Green Lake	215	7	143	65	48	2	2	2	2	1	-	7	15	14	3
Jefferson	262	2	152	108	75	-	6	7	9	6	-	16	18	9	4
Kenosha	44	-	39	5	11	-	-	-	-	-	-	-	5	4	2
Kewaunee	309	62	96	151	52	6	6	2	4	3	2	15	3	2	9
Manitowoc	679	166	225	288	148	39	20	5	8	7	4	36	8	4	17
Milwaukee	30	-	24	6	8	-	1	-	-	-	-	-	3	3	1
Outagamie	453	49	151	253	89	8	10	5	6	2	3	30	11	5	9
Ozaukee	122	7	39	76	24	-	1	1	2	2	-	13	2	1	2
Racine	110	4	93	13	31	1	2	-	1	1	-	1	13	10	2
Rock	255	-	228	27	74	-	-	2	1	-	-	2	45	19	5
Sheboygan	508	87	203	218	112	21	13	4	6	4	2	32	10	7	13
Walworth	150	1	129	20	36	-	-	1	-	1	-	1	16	13	4
Washington	378	11	200	167	99	1	16	4	11	6	-	34	13	11	3
Waukesha	185	3	124	58	38	-	1	1	2	1	-	5	14	10	4
Winnebago	176	19	103	54	44	4	2	1	2	1	1	6	15	9	3
Total	7,305	712	3,911	2,682	1,608	131	137	56	90	63	25	323	373	247	163
State total	97,864	17,658	37,817	42,389	16,279	3,925	1,922	615	508	878	813	1,771	(4,584)		1,263

1/ Net volume of live sawtimber and poletimber trees from stump to a minimum 4.0-inch top diameter (of central stem) inside bark. Does not include limbs or cull tree volume.

2/ Net sawtimber volume of trees of commercial species that contain at least one merchantable sawlog with a minimum top diameter inside bark of 8.0 inches. All softwood trees 9.0 inches or larger in diameter at breast height and all hardwoods 11.0 inches and larger are included.

3/ Includes sugar maple, yellow birch, river birch, beech, oak, ash, hickory, and black walnut.

4/ Includes aspen, red maple, silver maple, white birch, basswood, elm, balsam poplar, cottonwood, cherry, butternut, and willow.

5/ Includes red and silver maple.

6/ Standard survey cord of 80 cubic feet of solid wood.

7/ Board feet by the International Log Rule, 1/4-inch kerf.

\- Signifies less than 500 cords or 500,000 board feet.

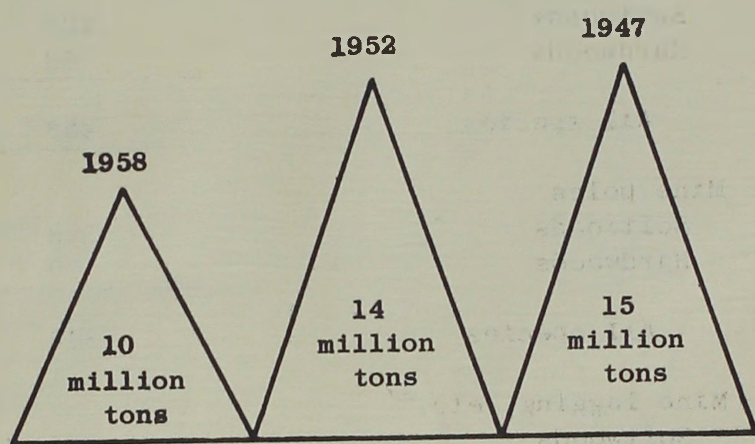
TECHNICAL NOTES
LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 570

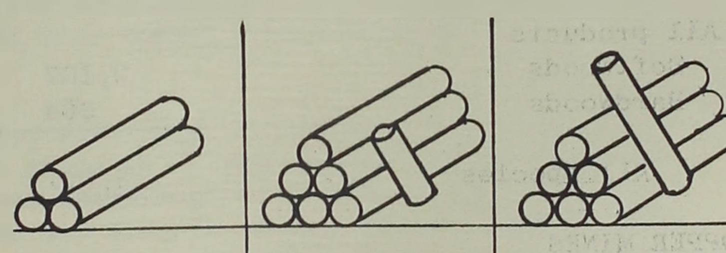
Mine-timber production declines as more substitutes are used and less ore is mined, Lake States, 1958

A canvass of Lake States mining companies was made early in 1959 to determine the quantity of round and split wooden mine materials cut for local mines. In recent years, the use of such timber products has been limited to underground mines. The open pit mines use lumber and other sawn materials but almost no round or split pieces.

Iron ore production and round and split wood requirements of underground mines, Lake States



Underground ore output



Round and split wood requirements

The Station's canvass shows 1958 local timber operators cut approximately 3-1/2 million cubic feet (45,000 cords) of round and split wooden mine products (see table on back of sheet). This is only about half the amount cut in 1952, the last year a similar survey was made. Mine stulls, lagging, poles, and cribbing made up most of the cut in 1958. About 90 percent of the timber products were used by the iron mines and 10 percent by the copper mines.

The quantity of round and split wood used in underground mining is generally proportional to the amount of ore produced. The 1958 decline in ore output resulted in a sharp drop in the production of mine timber products (see chart). The decline in ore production, however, is not the only deterrent to mine-timber production. Over the years substitute materials (steel replacing wood), the use of wood preservatives, and changes in mining methods have lessened the demand for wood. As a result, the amount of round and split wood used per ton of underground ore mined has decreased from 0.47 cubic foot in 1947 to 0.31 cubic foot in 1958.

OCTOBER 1959

ARTHUR G. HORN, Research Forester

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

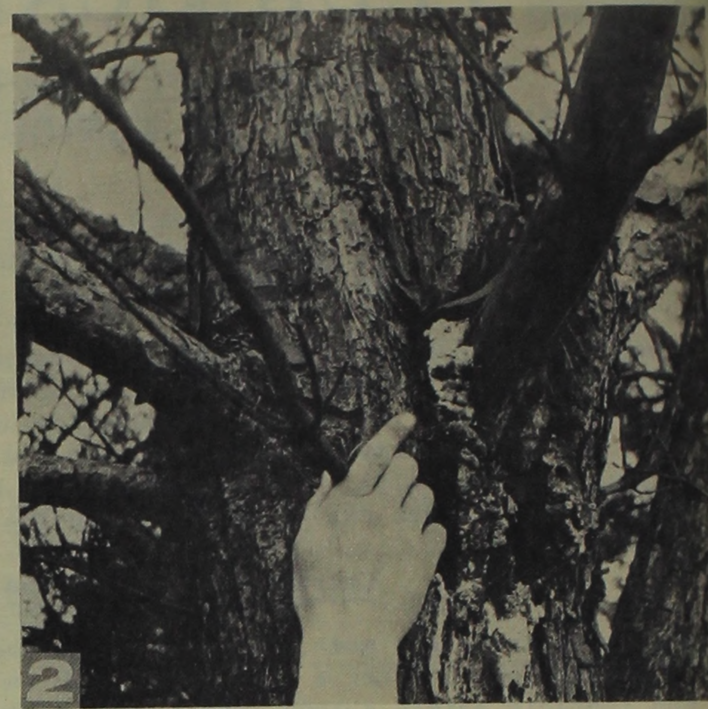



Figure 1.--European pine shoot moth injury to elongating shoots of Scotch pine.

Figure 2.--Pitch mass borer injury to main stem of Scotch pine.

Figure 3.--Zimmerman pine moth injury to elongating shoots of Scotch pine.

Figure 4.--Zimmerman pine moth injury to main stem of red pine.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 572

Blister Rust Spread is General in North, Local in South Wisconsin During 1958

During 1958 a program of observing the specific periods when various blister rust stages develop during the season was inaugurated by the Station with the aid of Blister Rust Control personnel of the North Central Region.1/ Hitherto the lack of such information has limited the possibilities of correlating weather data with the stages of rust.

Between 1938 and 1957 some sporadic records were made of blister rust infection on Ribes.2/ In general, most Ribes were defoliated because of rust infection by mid-August most years. Leaves were retained longer in 1951 and 1956 with apparent resultant increases in rust spread. Ribes defoliation histories through 1953 have been summarized by Van Arsdel.3/

Development of Rust on Ribes

Active aeciospore release in the north central States in 1958 was noted from April 29 at Hanover in southern Michigan to July 9 at Austin in southern Minnesota. Aeciospore release periods appeared to be shorter farther north.

Because of generally cool, dry weather in the early summer, uredial spread on Ribes was light and fairly late. Southern Michigan had little rust on Ribes and early drought defoliation of infected leaves. Northern Lower Michigan had widespread uredial rust by July 30, widespread telia by August 18, and heavy defoliation by September 18.

In southern Wisconsin uredia were noted July 16 south of Mineral Point; telia were noted July 31. Ribes infection never occurred on more than about 10 percent of the Ribes leaves, and defoliation was completed in mid-October. In northeastern Wisconsin more uredia were noted starting around June 15 and were general by July 23, with telia becoming fairly common by August 21. Defoliation was generally complete by September 26.

Southern Minnesota was sampled only once, but heavy uredia and telia were present July 8-11. With local exceptions, less than 15 percent of the northern Minnesota Ribes leaves had uredial infection.

1/ The authors wish to acknowledge the aid of Ray Weber and William Munyon of Blister Rust Control, who contributed observations on site and related rust stages in northeastern Wisconsin and Lower Michigan.

2/ In 1938 to 1941 E. E. Honey, U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering, kept detailed records in much of the North Central Region. In 1943 A. J. Riker, University of Wisconsin, and T. F. Kouba, then with the U. S. Bureau of Entomology and Plant Quarantine, kept records at Wisconsin Rapids. From 1951 to 1954 and late 1956 to 1957 the senior author of this Note kept some records.

3/ Van Arsdel, E. P. Climatic factors affecting the distribution of white pine blister rust in Wisconsin. Ph. D. Thesis, University of Wisconsin. 1954.

In all reported areas except southern Michigan defoliation of infected Ribes leaves was late, mostly because of low infection levels. This late defoliation gave better chances of fall pine infection. The amount of uredial infection increased from east to west and from south to north.

Spread of Rust to Pine

Repeated tests of teliospore fertility and spore-trap checks were made at Madison and about 20 miles south of Iron River, Mich. These studies raise some questions about the spread of sporidia and the weather favoring this spread.

In the area south of Iron River fertile teliospores that had released no sporidia were present August 19. On August 29, 30, and 31 three days of cool, humid, rainy weather occurred. On September 4 all teliospores present in a large sample had released their sporidia and had only empty sterigmata left. In subsequent September tests only a very rare telium was found to be able to produce sporidia. The presumptive evidence is strong that all sporidia were released in the one 3-day favorable period. Spore traps were not operating during the 3-day period, but the negative results from prior and later periods substantiated the limited release time.

Near Madison fertile telia were present on Ribes nigrum leaves on October 6. After 2 rainy, humid days (100-percent relative humidity on hair hygrometer), on the morning of October 9, sporidia had not been released from the basidia. These sporidia remained attached to the basidia for nearly a month until all leaves were dropped by the plant. However, sporidia had been released on water agar in Petri dishes where additional moisture was supplied and the sporidia were exposed to the same temperatures. From previous laboratory tests it seemed logical that the sporidia in the field should have been released in the wet period, but no spores were trapped and all could be accounted for as still attached to the basidia.

This year's observations of sporidial release seem to reinforce some previous observations that sporidia are released in mass. Sporidia were released all at once in a 3-day wet period in northern Wisconsin. At Madison a 2-day wet period almost completed the cycle but was not quite long enough. Spores remained attached to the basidia. The implications are that free water might be a deciding factor in the release of sporidia. (Additional moisture provided for a leaf in a Petri dish top under the same temperature conditions allowed spore discharge.) Our previous laboratory results showing the need of at least 2 days of wet weather might be too conservative. This may be due to the maintenance of supersaturated air in laboratory chambers so that water is constantly being deposited on the spores.

The year 1958 should have a general spread of rust to pine in northeastern Wisconsin, and southern Wisconsin should have local spread in areas with microclimates more favorable than the Madison test site.

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October 1959

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 573

Production of Miscellaneous Timber Products--Lake States, 1958

Every two years the Station surveys the production of miscellaneous forest products to determine the quantities cut in each of the three Lake States. The findings for the year 1958 are reported here.

Cooperage Logs.--The cut of cooperage logs in the Lake States amounted to about 4½ million board feet in 1958, most of the volume going into the production of whiskey barrels. Cooperage logs are one of the few forest commodities that showed an increase in production. Wisconsin continued to be the largest producer in the Lake States (see table on reverse side).

Piling.--More than 600,000 lineal feet of piling was produced in the Lake States in 1958. Minnesota producers accounted for nearly all of the softwood piling, and Michigan cutters for most of the hardwood piling. The 1958 cut, especially that of softwoods, was substantially more than the normal output. An expanded highway program, coupled with the quickening of commercial and residential construction in some areas, increased the demand for piling. Unusually long hardwood piling was much in demand but hard to get.

Poles.--More than 230,000 poles were cut from Lake States timber in 1958. This was an increase of approximately 36 percent over the 1954 harvest. Northern white-cedar and red pine poles showed the greatest increases. An active market for poles to be used in constructing pole-type farm and commercial buildings contributed to the upturn in production in 1958.

Chemical and Charcoal Wood.--The local cut of chemical and charcoal wood amounted to approximately 169,000 cords in 1958. This production was approximately 28 percent below that of 1956--the year of the last previous survey. Nearly three-fourths of the 1958 cut was made up of low-grade logs and bolts taken from the woods, while the remainder came from sawmill slabs, veneer cores, and other mill residues. Compared to 1956, wood procurement at large plants dropped off considerably in 1958, whereas it increased at most of the small plants.

Excelsior Bolts.--The survey shows that 53,000 cords of excelsior bolts were cut in 1958, 39 percent less than in 1956 and a new low for this product. This slump reversed a strong upward trend in excelsior production which has been evident since 1950. Wisconsin plants produce most of the baled excelsior while Michigan plants specialize in excelsior padding.

Heading Stock.--Mill closures and reduced levels of operation at many container veneer plants in 1958 resulted in a weakening of the market for heading stock. In 1958 the cut of heading stock amounted to only 12,000 cords in the Lake States compared to 16,000 cords in 1956--a 25 percent decrease. Cardboard and plastic containers have cut deeply into markets for wood veneer containers.

(over)

OCTOBER 1959

BURTON L. ESSEX,
Research Forester

Production of miscellaneous timber products, Lake States, 1958

Species	Minnesota	Wisconsin	Michigan	Total
COOPERAGE LOGS (MBF Int'l 1/4" Rule)				
Basswood	213	-	-	213
Oak	352	3,781	-	4,133
All species	565	3,781	-	4,346
PILING (M lineal feet)				
Softwood	219	81	8	308
Hardwood	-	54	253	307
All species	219	135	261	615
POLES (M pieces)				
Pine	93	14	-	107
Cedar	83	25	17	125
All species	176	39	17	232
CHEMICAL AND CHARCOAL WOOD (M std. cords)				
Hardwoods	6	17	98	121
Mill residue	*	22	26	39
All species	6	39	124	169
EXCELSIOR BOLTS (M std. cords)				
Aspen	*	33	20	53
Basswood	-	*	-	*
All species	*	33	20	53
HEADING STOCK (M std. cords)				
Aspen	1	5	*	6
Hardwoods	1	5	*	6
All species	2	10	*	12

* Less than 500 cords.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 574

1959 Forest Tree Seed Crop Generally Poor in the Lake States

Forest tree seed production in general was about equal to that in 1958 and was poorer than in any year since 1949 for the 14-year period of record, according to observations made at field centers of the Lake States Forest Experiment Station (see table on reverse side). Nevertheless some species produced bumper crops in northeastern Wisconsin and good crops in other localities. Seed crops of most tree species varied by localities from failure to fair or good. Compared to 1958 general seed production was better in northern Minnesota and North Dakota, about the same in northeastern Wisconsin, and poorer in Michigan.

In northern Minnesota good crops were reported for some localities for black spruce, northern white-cedar, tamarack, paper birch, and quaking aspen. Seed crop failures occurred in one or more localities in balsam fir, black ash, bur oak, and northern red oak.

Bumper crops were produced in northeastern Wisconsin by eastern white pine, basswood, yellow birch, and white ash. Good crops were reported for black spruce, balsam fir, quaking aspen, bigtooth aspen, and American elm. Only tamarack had a crop failure, although several other species had poor crops.

Only red maple and yellow birch had good seed crops in central Upper Michigan. The seed crop was a failure for eastern white pine, white spruce, black spruce, balsam fir, American beech, American elm, and black ash. Other species had poor to fair crops.

Northern white-cedar was the only species with a good seed crop in Lower Michigan. No other species had better than a poor seed crop there.

In north-central North Dakota boxelder, green ash, bur oak, and chokecherry produced good seed crops. Seed crops failed for American elm, Siberian elm, hackberry, and Russian-olive. They were poor for other species.

Most seed collectors are interested chiefly in the pines. Except for white pine in northeastern Wisconsin, therefore, they will consider 1959 a poor seed year in the Lake States. It also promises to be a bad year in northern Minnesota and Lower Michigan for wildlife species that depend on mast. Conditions appear only fair in northeastern Wisconsin and Upper Michigan.

January 1960 PAUL O. RUDOLF, Research Forester

Table 1.--Forest tree seed crops in the Lake States, 1959

Species	Estimated percentage of a full crop[1] in --				
	Northern Minnesota	Northeastern Wisconsin	Central Upper Michigan	Lower Peninsula Michigan	North-central North Dakota
Red pine	25-50	25	25	7	[2]-
Eastern white pine	25	95	7	7	-
Jack pine	25-50	25	50	25	-
Ponderosa pine	-	-	-	-	25
White spruce	25-50	25	7	25	-
Black spruce	50-75	75	7	7	-
Norway spruce	-	25	-	-	-
Balsam fir	7-25	75	7	7	-
Eastern hemlock	-	50	25	-	-
Northern white-cedar	50-75	25	50	75	-
Tamarack	25-75	7	-	7	-
Sugar maple	25-50	25	25	7	-
Red maple	-	-	75	7	-
Boxelder	-	-	-	-	75
American beech	-	-	7	7	-
Basswood	-	95	50	-	-
Yellow birch	-	95	75	-	-
Paper birch	25-75	50	-	25	-
Quaking aspen	25-75	75	-	25	-
Bigtooth aspen	-	75	-	25	-
Balsam poplar	-	-	-	-	-
American elm	-	75	7	25	7
Siberian elm	-	-	-	-	7
Hackberry	-	-	-	-	7
White ash	-	95	-	-	-
Green ash	-	-	-	-	75
Black ash	7	25	7	-	-
Bur oak	7-25	-	-	-	75
Northern pin oak	-	-	-	7	-
Black oak	-	-	-	7	-
Northern red oak	7-25	25	50	7	-
White oak	-	50	-	7	-
Chokecherry	-	-	-	-	75
American plum	-	-	-	-	25
Russian-olive	-	-	-	-	7
Caragana	-	-	-	-	25

1/ Percentage of a full crop classified as 0-15, failure; 16-35, poor; 36-60, fair; 61-90, good; and 91-100, bumper.

2/ A dash (-) signifies no report on this species.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 575

August-Collected Cones Yield Poor Red Pine Seed

Past work by the Station has shown that the seed of red or Norway pine is not of top quality until the cones have turned deep purple with the tips of the scales showing brown. At this time, freshly picked cones have a specific gravity of 0.85 and will float in kerosene (Technical Note No. 170). Once this degree of maturity is reached, there is usually a 20- to 30-day period during which the cones may be harvested without appreciable loss of seed. There is consequently no excuse for the collection of unripe cones.

The serious loss in seed quality that occurs when these simple indications of cone maturity are ignored is emphasized by the results of a test made on two lots from the heavy 1957 crop of red pine seed. One of these lots was a representative sample of the seed from about 200 bushels of cones collected during the third week of August when the cones were still green; the other came from a slightly larger cone lot collected about 3 weeks later in the middle of September.

Shortly after collection both lots were spread out in sheds to dry. In October they were run through a standard kiln with forced circulation and controlled temperature and humidity. The seed was then shaken from the cones, cleaned, and stored at 50° F. until the time of testing in mid-November.

Germination tests made in petri dishes showed striking differences in quality between the seed from the two collection dates. First was a difference in soundness. Although the two lots were given identical cleaning treatment, the August lot showed 8 percent empty seeds compared with none for the September collection. More important, however, was the difference in germination; only 54 percent of the filled seeds of the August lot germinated compared with 85 percent for those from the September cones. The expected nursery germination of the August seed would therefore be 22 to 38 percent (0.4 to 0.7 of laboratory germination), which rates the seed as of dubious value. Furthermore, the August seed was heavily contaminated with mold, which probably would reduce nursery germination even more.

Another count against these green cones was their higher extraction cost and lower yield. Not only were the August cones much more difficult and hence more costly to open, but they yielded only 10½ ounces of clean seed per bushel compared with 13½ ounces for the cones collected in September. The difference of more than 20 percent resulted in an appreciably higher cost of production for this decidedly inferior seed.

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Obviously red pine cones cannot be gathered in August and still produce a good yield of high-quality seed. Even the middle of September can be too early, for the seed produced by such cones in 1957 showed only 85-percent germination. This is at least 10 percent lower than the germination which experience indicates should be obtained for the best red pine seed in petri-dish tests.

Since red pine cone development varies with weather conditions, cone maturity cannot be foretold from the calendar with any assurance. Much more reliable is the method described in Technical Note No. 170. If the majority of freshly picked cones from several representative trees in the stand will float in kerosene, the cones are mature and should produce seeds of high quality.

Similar guides have been developed for determining ripeness of white pine and white spruce cones. Further research should be conducted to determine if flotation cannot be used to determine maturity in the cones of other important Lake States conifers.

January 1960 EUGENE I. ROE, Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
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No. 576

Soil Freezing Observations After Changes in Forest Cover

The presence and depth of concretely frozen soil over extensive areas can have serious hydrologic effects. Concrete frost is a very dense type of frost in which soil particles are cemented together by frozen ice crystals or lenses. It is almost impermeable to the passage of water, thus posing a serious threat to recharge of soil-moisture deficits and ground-water tables during early spring snowmelt. In hilly areas it can cause overland runoff which contributes to spring floods.

Forest cover influences the formation of concrete frost in a number of ways. It affects the depth of the insulating blanket of snow on the ground, the type and depth of humus formed, and the amount of heat reaching the forest floor. A change in forest cover can alter each of these factors.

Differences in soil freezing after forest conversion were observed during the late winter and early spring of 1957 and 1958 at the Pike Bay Experimental Forest near Cass Lake, Minn. Part of a large area of brush and inferior aspen had been converted to red pine in 1937. Prior to planting, the area had been cleared of hardwoods, plowed, and disked. In 1956 the pine plantation supported 94 square feet of basal area per acre, and the adjacent original stand supported 54 square feet of basal area per acre. The soil under each stand was classified as a Nebish loamy fine sand over a heavy clay loam.

Ten frost observations in each area were taken on the dates indicated in table 1. Frost was identified by chopping small pits, and depth of freezing was measured with a penetrometer.

In both years concrete frost was deeper and remained longer in the spring in the pine plantation than in the nearby aspen-brush area. Over the 2-year period concrete frost was observed at 76 percent of the sampling points in the plantation and at 57 percent of the points in the aspen-brush area.

Variations in humus type and depth and snowpack depth help explain the differences in frost penetration. Under the aspen-brush stand a duff-mull type humus was found with an average depth of 3.3 inches and some organic matter incorporated in the mineral soil. A mor humus developed under the plantation. It averaged only 1.5 inches in thickness with almost no organic material incorporated in the mineral soil. Early winter snow depths averaged 1.7 inches deeper in the aspen-brush stand. Below-normal temperatures and an extremely light snowpack were probably responsible for deeper frost penetration during the winter of 1958.

Table 1.--Depth and occurrence of concrete frost under a red pine plantation and an aspen-brush stand

Sampling date		Red pine plantation: Average frost depth 1/	Red pine plantation: Occurrence of frost	Aspen-brush stand: Average frost depth 1/	Aspen-brush stand: Occurrence of frost
		Inches	Percent	Inches	Percent
1957					
February	5	4.6	80	3.0	90
	19	3.6	100	3.0	100
March	4	7.7	80	4.2	100
	22	6.6	90	3.3	90
	28	10 +	100	3.9	90
April	4	3.4	40	2.8	80
	11	2.6	20	1.2	30
	17	1.0	20	0	0
1958					
March	17	10 +	100	6.5	100
	28	10 +	100	6.7	100
April	2	10 +	100	2.7	60
	9	10 +	100	.7	20
	15	10 +	100	0	0
	18	10 +	90	0	0
	23	.9	20	0	0

1/ Total frost depth divided by total number of observations, where zero is a valid observation. Frost depths beyond 10 inches were recorded as 10 +.

Measurements of snowmelt characteristics under the two stands indicate snow remained longer under the red pine plantation. On the last date frost was found in 1957 the snowpack averaged 10.8 inches deep and contained 3.2 inches of water under the pine. In the adjacent aspen-brush area average snow depth was only 6.6 inches with a moisture content of 2.0 inches. Thus, in a normal snowpack year the disadvantages of deeper and longer lasting soil freezing under the plantation were offset by delayed melting of snow. This was not true for 1958, however, when the below-normal snowpack disappeared by early March. Under these circumstances delayed thawing of frozen soil under the plantation would seriously affect infiltration of early spring rains.

January 1960 ROGER R. BAY, Research Forester

TECHNICAL NOTES
LAKE STATES FOREST EXPERIMENT STATION
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No. 577

Moisture Storage By Leaf Litter[1/]

In the 1930's the Lake States Forest Experiment Station operated a series of lysimeters at La Crosse, Wis. In connection with this, the researchers wanted to know how much rainfall was caught and held by the litter layer that had been placed on the lysimeters as part of their treatment. This Note reports their findings.[2/]

Six boxes, 1 square foot in area, were constructed, with bottoms of screen wire. Square-foot samples of litter were taken from the lysimeters and placed in the boxes. Three samples were hardwood litter and three were Scotch pine. Their weights, representing 2 to 3 inches in litter depth, were as follows:

Hardwood litter (Pounds)	Pine litter (Pounds)
1.58	0.95
1.62	0.96
1.52	1.00

Galvanized tanks were placed under the boxes to catch the rain that filtered through the litter. This was measured after each storm for three growing seasons, during which 136 storms occurred. Precipitation was measured with a recording rain gage. Moisture retained by the litter was computed as the difference between the amount of precipitation and the volume of water in the tanks. Average values for each set of three boxes were used in computing the amounts held by the two litter types.

Since the test boxes were located in the open and received full effects of radiation, wind, and other factors which influence wetting and drying of leaves, the data only approximate the amounts of rain that might be stored in the litter under a natural forest canopy.

1/ This study is one phase of the watershed management research being conducted in cooperation with the Wisconsin Conservation Department.

2/ The data were collected by Robert G. Neu, now with the Agricultural Research Service, U. S. Department of Agriculture, at Madison, Wis.

The amount of moisture held by both the hardwood litter and the pine litter was nearly the same--34.2 percent and 33.2 percent respectively of the total precipitation for the 3 years (table 1). The amount retained varied by size of storm. From rains of less than 0.25 inch, 93.7 percent of the total amount was retained by each litter type; for rainfalls over 1.00 inch only about 11 percent was held in the litter. What does this mean in terms of inches of water? For hardwood litter the average was 8.7 inches, for Scotch pine litter, 8.4 inches. Since the hardwood litter weighed about one-third more than the pine litter, one might infer that pine litter of equal weight would intercept more moisture.

From the lysimeter study, researchers have learned that litter plays a complex role. Its influence in maintaining high infiltration and reducing surface runoff and erosion is now established. This study shows that the ability of litter to store moisture may also be an important hydrologic function.

Table 1.--Summary of precipitation stored by leaf litter

Precipitation class	Number of storms	Total precipitation	Moisture stored in-- Hardwood litter		Scotch pine litter	
		Inches	Inches	Percent	Inches	Percent
0-0.25 inch	56	5.71	5.35	93.7	5.39	93.7
0.26-0.50 "	26	9.51	6.31	66.4	6.12	64.4
0.51-1.00 "	35	25.03	10.38	41.5	9.87	39.4
Over 1.00 "	19	35.71	3.96	11.1	3.86	10.8
Total or average	136	75.96	26.00	34.2	25.24	33.2

WILLIE R. CURTIS, Research Forester
La Crosse Research Center

January 1960

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 578

The Search for Resistance to Chestnut Blight in the Lake States

Our history books are rich in accounts of the flourishing stands of American chestnuts that once covered large areas in the eastern United States. These chestnuts were an important source of quality timber for construction purposes. They also were a source of tannins and dyes and, in addition, supplied food for human consumption as well as for wildlife. These qualities made American chestnut very important to the economy of the Nation.

The situation changed rapidly after the introduction of chestnut blight into the United States in 1904. The native American chestnut was a very susceptible host and within a few years the disease had spread throughout the natural range of the tree. Virtually all of the chestnuts were killed by the fungus. This was a great loss to the Nation since no other tree has been found to replace chestnut satisfactorily.

Various workers are attempting to develop a blight-resistant chestnut that has the desirable characteristics of our native tree. One approach being used is to cross our native stock with Asiatic chestnut, which is resistant but has poorer fruit and timber qualities. Another approach is to search out any surviving trees with the thought that these may possess natural resistance. If specimens of this type are found, they will be propagated and tested under various conditions to determine if they actually are resistant. To locate specimens of this type, the U. S. Forest Service has given considerable publicity to the program, especially in periodicals that reach sportsmen and naturalists. This publicity has taken the form of a request for information on any trees found.

A surprisingly large number of reports of chestnut trees in the Lake States have been received as a result of this publicity. Most of these reports involve planted trees, since within the Lake States only a small part of southeastern Michigan is included in the natural range of American chestnut.

It has not been possible as yet to check all of the trees reported. Several of those that have been checked are mature, and some produce viable seed, as evidenced by numerous seedlings developing in the vicinity. None of the trees examined so far shows any evidence of having been infected by chestnut blight, nor are any of the live trees in the vicinity of dead and possibly infected trees. Very likely these trees are "escapes," since they are growing in isolated locations outside of the normal range of American chestnut and therefore there has been little opportunity for infection to occur. Infections will likely be encountered as more trees are examined since the disease is known to be present in the region.

Although no positive evidence of blight resistance has been found up to this time, the Station will continue to check reported trees in this area. Any person with information regarding mature American chestnuts in the Lake States is asked to contact this Station.

January 1960

GERALD W. ANDERSON, Research Forester

MAINTAINED AT ST. PAUL 1, MINNESOTA IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 579

A Field Test of the Baker Seed Tool in Northeastern Minnesota

Because of the high cost of planting, there has always been a keen interest in the possibility of direct seeding as a means of obtaining conifer regeneration. Over the years, however, direct seeding trials have had rather spotty success in the Lake States.

The Lake States Forest Experiment Station has conducted trials of direct seeding with conifers since about 1926. These trials were conducted with various species under a wide range of weather and seedbed conditions. Some of the tests were highly successful; others were complete failures. The failures could usually be attributed to adverse weather conditions, poor seedbeds, aggressive competing vegetation, or seed-eating rodents.

Various direct seeding devices have been developed to try to improve field germination and survival, and also to conserve seed. One such device is the Baker hand-seeding tool reported on here. Essentially, the tool is a hollow metal tube with a handle and seed hopper at the top, and a plunger at the lower end which pushes the seed into the ground after it has dropped through the tube. The number of seeds released each time depends upon the size of the seed being sown and on the size of the selector device being used.

The Baker tool was tested during 1953 at six different locations on the Superior National Forest in northeastern Minnesota. The areas had been logged from 1 to 6 years previously. On each area seeding was done in May, June, July, September, and October, using red pine and jack pine seed. The treatments tried were: (1) seeding on duff and screening, (2) seeding on scalped spots and screening, (3) seeding on duff with no screening, and (4) seeding on scalped spots with no screening.

Results varied considerably by treatment, but no treatment was very successful. Table 1 summarizes the findings at the end of 3 growing seasons. Although stocking was poor in all cases, the table shows some definite trends. Spring and early summer seeding, for example, was consistently better than fall seeding. Even the poorest of the spring sowings (3.2 percent stocking) was better than the best fall sowing (2.4 percent), and the best spring sowing was three times as good (7.6 percent).

(over)

Table 1.--Percent of spots stocked at end of third year including both screened and unscreened spots 1/

Species	Ground treatment	Month seeded (all areas combined) May	June	July	Sept.	Oct.
Jack pine	Scalped	3.2	6.8	4.8	1.2	2.4
	Unscalped	4.8	5.2	4.0	2.4	1.6
	Average	4.0	6.0	4.4	1.8	2.0
Red pine	Scalped	4.8	3.6	4.0	1.2	1.6
	Unscalped	7.6	6.4	5.2	1.2	2.0
	Average	6.2	5.0	4.6	1.2	1.8

1/ One-fourth of the spots were screened for the first 2 years.

The table also shows that red pine had better survival on unscalped than on scalped spots. This was true for each of the 5 months except September which showed no difference in survival between the two treatments. For jack pine neither treatment showed a clear-cut advantage. Scalped spots showed higher survival for 3 of the 5 months, but unscalped spots were better for the other 2. For red pine the poorer survival on scalped spots seemed to be due to the filling up of these spots with leaves, which smothered some of the seedlings. The faster growing jack pine seedlings were apparently less affected by this problem.

Screening was decidedly beneficial for both species. Besides affording protection against rodents and birds, the screens also provided some shade. On the average, screened spots had about four times as good survival as unscreened spots.

Results also varied considerably by area. Best results were obtained in the spring seeding (May and June) on an area which had been logged 1 year before seeding. Third-year stocking for the May seeding here averaged 16 percent for red pine and 10 percent for jack; for the June seeding it was 11 percent for red pine and 10 percent for jack pine. Even if 10-percent survival could be consistently relied upon, this would still require 5,000 seed spots per acre in order to have 500 stocked spots per acre after 3 years.

Based on these tests, the Baker seed tool cannot now be considered a successful device for restocking upland cutover areas in northeastern Minnesota. Future trials and more research on seedbeds, microclimate, etc., may change this picture.

R. O. STROTHMANN
D. F. CONOVER1/
Research Foresters

April 1960

1/ Former member of the Station staff; now Instructor, Wisconsin State College, Oshkosh.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 580

The Poplar Borer in Relation to Aspen Stocking

Increased interest in better management of aspen has focused attention on the amount of damage caused by primary pests and on silvicultural methods that will minimize the damage. One of these pests, the poplar borer (Saperda calcarata Say), is a roundheaded borer found in the majority of aspen stands throughout the Lake States. The large, oval-shaped larval tunnels of this pest make trees susceptible to wind breakage, serve as openings for the introduction of various rots and decays, and cause a degrade in log value.

Successful borer attacks are almost always concentrated in individual trees or small groups of trees unevenly distributed throughout the stand. These "brood trees" are usually the larger, faster growing trees in stands that average between 3 and 7 inches d.b.h. (diameter at breast height). However, preliminary investigations have failed to reveal any gross differences in size or growth rate between adjacent attacked and unattacked trees. It has been suggested that the initial successful attack occurs on a random basis; successive generations then tend to attack the same tree.[1/] After heavy repeated attacks, brood trees remain alive but are abandoned by the borers and only their blackened, scarred trunks give evidence of their previous inhabitants.

Because of the uneven distribution of attacked stems, the variation in percentage of poplar borer infestation on small plots in a given area is very large; therefore impact data based on a relatively small number of small plots cannot be interpreted with great confidence. However, analysis of data from 145 tenth-acre plots in the northern portions of the Lake States shows certain trends in infestation that may at least serve as a starting point for future research. These plots were established by the Station during the early 1950's to investigate Hypoxylon canker, but data on the occurrence of the poplar borer were also recorded and are used here.

Of the 145 plots, 42 contained no attacked stems, 77 had from 1 to 10 percent of the total stems infested, and the remaining 26 had 11 to 65 percent infestation. No attempt was made to differentiate between heavily and lightly attacked stems because generally successive generations of the borer heavily infest all attacked trees.

When the plots were grouped according to d.b.h. class, a definite pattern emerged: the larger the average d.b.h., the higher the poplar borer infestation (fig. 1). Although plots with average tree diameters of over 7 inches were too few to determine whether the trend line would turn down, the rough, thickened bark of the larger stems is thought to be less suitable for oviposition.

Grouping according to number of stems per plot also yielded a strong correlation (fig. 2). As the number of stems per 1/10 acre increased beyond 40, the infestations decreased. As would be expected, the plots with higher stocking levels had smaller average d.b.h.'s.

No attempt was made to define a three-dimensional relationship between the infestation, average d.b.h., and stocking level because of the lack of a sufficient number of combinations. Even without a continuous range of stocking and d.b.h. combinations, however, the data show that poplar borer infestations tend to vary directly with stem diameter and inversely with density of stocking.

In managing aspen, therefore, intermediate cuts of any kind will probably increase borer damage. In Canada, even periodic removal of infested trees proved worse than no cutting, because the reduction in stand density caused an increase in new infestations. Apparently the best practice would be to maintain well-stocked stands and then to clear cut them at maturity.

April 1960

HERBERT G. EWAN, Entomologist

1/ Peterson, L. O. T. Some aspects of poplar borer infestations under parkbelt conditions. Canada Dept. Agr. Sci. Serv., Contrib. No. 2528, 6 pp., 1947.

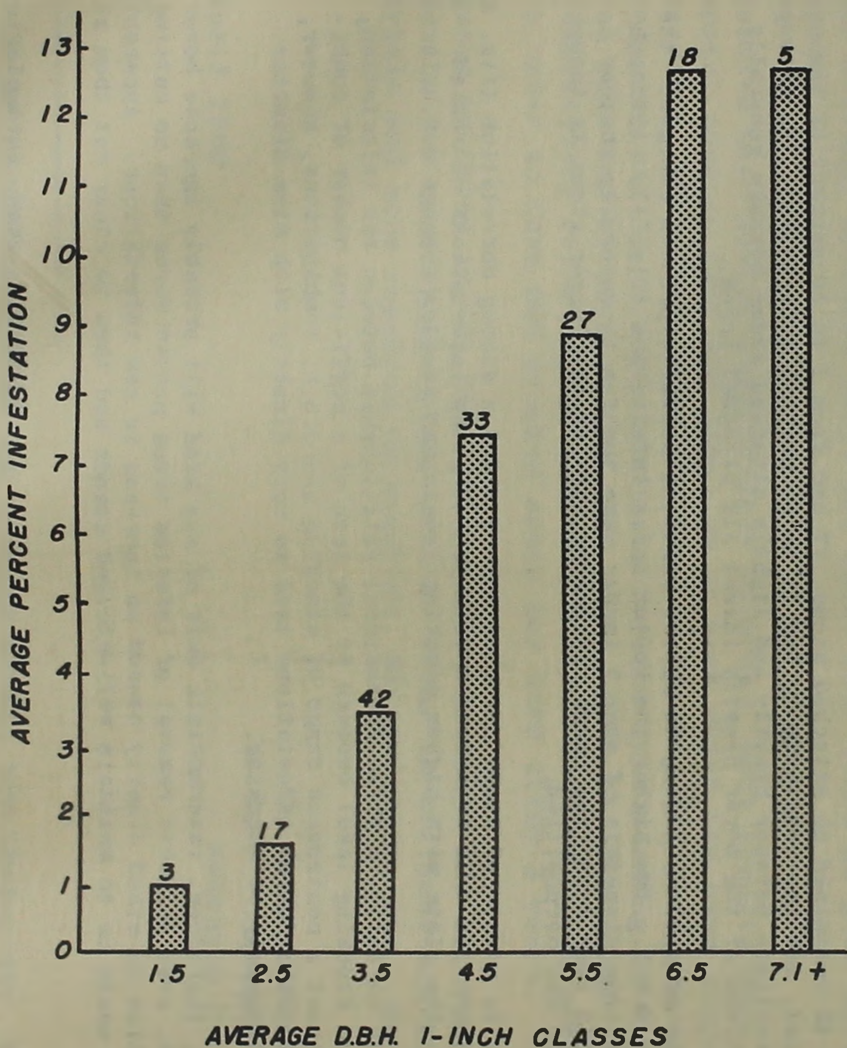

Figure 1.--Average percentage saperda infestation per 1/10-acre plot related to average tree diameter per plot. Figures at top of bars show the number of plots.

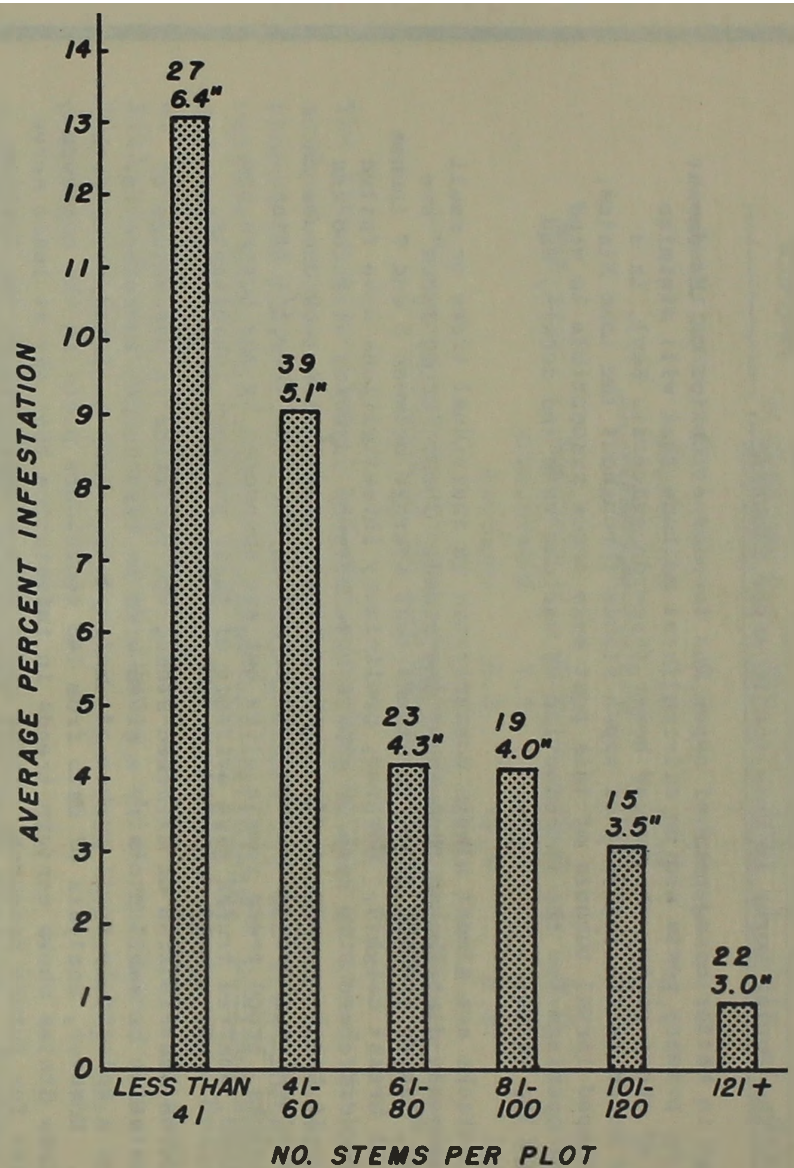

Figure 2.--Average percentage saperda infestation per 1/10-acre plot related to number of aspen stems per plot. Figures at top of bars show the number of plots and the average tree d.b.h.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 581

Initial Effect of Residual Stocking Levels on Basal Area Production in Northern Hardwood Stands

Selection management in old-growth northern hardwood stands has been under investigation in the Lake States for the past 30 years. Past studies indicated that this timber type reacts favorably to all-aged management with satisfactory yields from periodic cuttings made at relatively short intervals. From these early studies we also learned that growth in partially cut stands was related to residual stand density.

In 1951 a stocking level study was initiated to provide additional information on the relationship between residual stand density and growth, quality, and composition. The experiment was designed to test the following stocking levels: 30, 50, 70, and 90 square feet of basal area per acre in trees 10 inches diameter breast high (d.b.h.) and larger.

Three replications were established in fully stocked old-growth hardwood stands on the Dukes Experimental Forest. These stands were typical of northern hardwoods which grow on the better-drained sites of the Upper Peninsula. Before cutting they contained from 110 to 120 square feet of basal area per acre and about 15,000 board feet gross or 11,000 board feet net. Sugar maple, the predominant species, comprised about 75 percent of the net volume. Yellow birch accounted for 17 percent.

Five years after cutting, the stands were remeasured to determine net growth, mortality, and gross basal area production. Net growth equals the change in basal area which occurred during the 5-year span. Mortality measures total stand losses during this period. Gross basal area production is a combination of net growth and mortality and measures total productive capacity.

A summary of the 5-year changes in basal area increment showed that some of the differences in growth and mortality were attributable to the level of residual stocking (table 1). The gross basal area production of the 30-foot stocking level was significantly less than the gross production in stands with a residual stocking of 50, 70, and 90 square feet. Although there was no significant difference between levels of 50, 70, and 90, a residual stocking of 70 square feet had both the largest gross and the largest net production. In terms of board-foot growth the basal area production in the 70-foot level is equivalent to an annual increment of approximately 170 board feet per acre. Net annual growth in stands with either 50 or 90 square feet of basal area was about 150 board feet per acre. It was only 100 board feet per acre in stands with a residual stocking of 30 square feet.

(over)

Residual stocking level had no significant effect upon the basal area production of understory trees 5 to 9 inches d.b.h. The trends, however, were just the opposite to those observed for overstory trees (table 2). The basal area production of these smaller trees was greatest in the 30-foot level and least in the 70. Losses, however, were also greatest in stands with a residual stocking of 30 square feet.

Table 1.--Change in basal area for trees 10 inches d.b.h. and above during the 5 years following the initial cut

(In square feet per acre)

Residual stocking level	Basal area following first cut	Basal area 5 years later	Net growth	Mortality	Gross basal area production
30	29.3	33.6	4.3	1.5	5.8
50	47.6	53.5	5.9	1.3	7.2
70	67.0	73.5	6.5	1.3	7.8
90	84.2	89.4	5.2	2.2	7.4

Table 2.--Change in basal area for trees 5 to 9 inches d.b.h. during the 5 years following the initial cut

(In square feet per acre)

Residual stocking level	Basal area following first cut	Basal area 5 years later	Net growth	Mortality	Gross basal area production
30	8.2	9.1	0.9	1.0	1.9
50	8.1	9.6	1.5	.2	1.7
70	8.6	9.7	1.1	.2	1.3
90	7.8	9.1	1.3	.2	1.5

The period immediately following the initial harvest is primarily one of adjustment for all stand components. Trends in basal area growth established during this 5-year span, therefore, may not be indicative of those occurring in the future.

April 1960

THOMAS W. CHURCH, Jr., Research Fores

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 582

Water Sprays Will Shorten Charcoal Cooling Time

Charcoal is produced in kilns by carbonizing wood at about 800° to 950° F. Following carbonization, the kiln is sealed to prevent air entry and allowed to cool. Kiln temperatures must fall below 200° F. before it is considered safe to open for unloading.

Kilns are usually cooled by natural radiation of heat through the walls and ceiling. Rate of cooling depends primarily on the thermal conductivity of the structure. Time required for cooling by natural radiation is usually greater than the carbonization time.

In August 1959, the Lake States Forest Experiment Station made a preliminary test with water sprays as a means of reducing cooling time. Water was sprayed over the top of charcoal in a 3-cord kiln. Spraying, begun immediately after carbonization was complete and when kiln temperatures were about 900° F., was continued intermittently for 4 hours until kiln temperatures were about 200° F. A total of 650 gallons of water were injected through two spray nozzles mounted on a 3/4-inch-diameter supply pipe. Weight of the charcoal in the kiln was about 2,100 pounds.

Cooling time with spraying was 13 hours compared with an average of 60 hours by natural radiation (fig. 1).

The results of this test, as well as exploratory work reported by Hicock *et al.*[1] and Kotok,[2] indicate that water sprays may be an effective means for reducing cooling time in charcoal kilns. More research is needed to improve the technique and to determine any effects cold-water sprays may have on kiln structures and the quality of charcoal.

JAMES C. WARD and PAUL H. LANE
Technologists, Forest Products Utilization

April 1960

1/ Hicock, H. W., Olson, A. R., and Callward, F. M. The Connecticut charcoal kiln. Univ. Conn. Agr. Expt. Sta. Bul. 431, 48 pp., illus. 1951.

2/ Kotok, E. W. The production of charcoal from Arizona mesquite. U. S. Forest Serv., Rocky Mountain Forest and Range Expt. Sta. Res. Note 15, 6 pp. 1955. (Processed.)

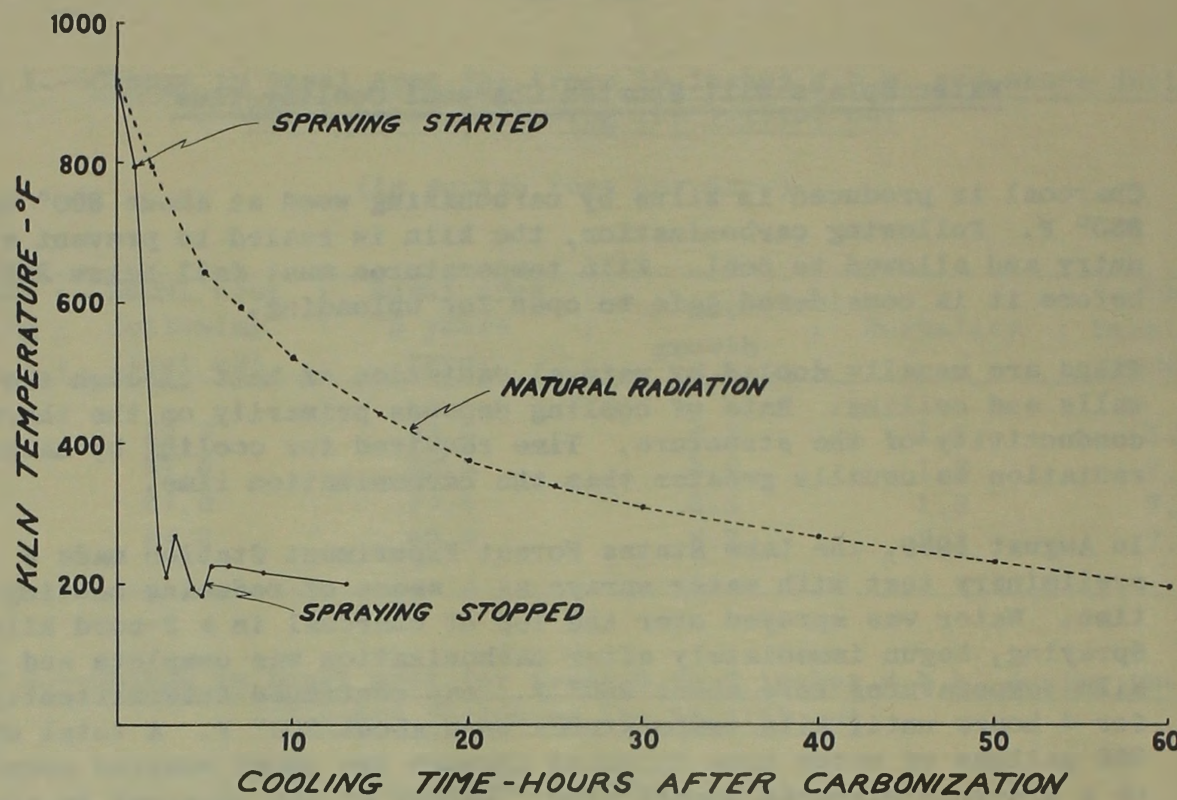

Figure 1.--Cooling curves for experimental 3-cord charcoal kilns; the use of water sprays compared with natural radiation. Temperature fluctuations during water spraying were caused by intermittent spraying. The natural radiation curve was based on seven experimental burns; the water-spray curve on one burn.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 583

Reducing Pulpwood Losses from Borer Attacks by Shading Conventional Pulp Piles

During extensive spring and summer cutting of spruce and balsam fir, care must be taken to prevent or minimize heavy wood-borer damage in the piled pulpwood. Generally, this can be done by either (1) peeling, (2) spraying with insecticides, or (3) removing the logs from the woods within a few days after cutting. At times, however, especially in a major operation, conditions are such that none of these methods can be used.

If heavy mortality of spruce and balsam fir follows the present epidemic outbreak of the spruce budworm (*Choristoneura fumiferana* (Clem.)) in northern Minnesota, extensive salvage operations will be necessary, or heavy losses of wood will result. In anticipation of this possibility, the Station established a study in 1958 to determine whether any particular method of piling pulpwood would protect the sticks from attack by wood borers.

Several balsam fir and a few white and black spruce trees were cut into the usual 100-inch sticks. The balsam fir sticks were piled into standard pulpwood piles (fig. 1) and modified pens (fig. 2). One pulpwood pile and one pen were set up in a small clearing; another of each was piled in the shade beneath living conifers. Supplementary piles containing 4 to 6 sticks of balsam fir or white and black spruce were placed in the clearing. Data from white and black spruce were not separated.

In this study the white-spotted sawyer (*Monochamus scutellatus* (Say)) caused over 95 percent of the insect damage. This suggests that prevention of *Monochamus* attacks would substantially reduce wood loss in pulpwood piles.

Monochamus females lay most of their eggs in pulpwood sticks on warm sunny days. Consequently the standard pile and the pen in the clearing were the most vulnerable to attack. The sticks on the interior of the standard pile, which were shaded and less accessible to the insects, averaged 19 larvae, while the exterior sticks averaged 182 larvae. Since the sticks of the pen were all exposed, they were equally susceptible to attack and averaged 182 larvae.

The standard pile in the shade averaged only 3 larvae per stick on the interior of the pile and 26 larvae in the exterior ones. This relationship was similar to the pile in the clearing but with about one-seventh the number of insects. The pen in the shade averaged only 16 larvae per stick.

Sticks sampled from the exterior of the small supplementary piles averaged 206 larvae in balsam fir and 378 in spruce.

To reduce borer attacks it is recommended that, whenever possible, pulpwood be piled in standard piles under the shade of standing trees if other preventive measures cannot be undertaken. In the absence of standing trees, when clear cutting is practiced, fresh boughs should be laid over the pile to provide the necessary shade. Spring- or summer-cut wood, piled in the forest, should be removed before the following spring; otherwise wood-infesting fungi become important.

April 1960

LOUIS F. WILSON, Entomologist

IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Figure 1.--Standard pulpwood pile of balsam fir sticks piled in the shade of standing trees.

Figure 2.--Modified pulpwood pen of balsam fir sticks piled in a clearing.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 584

Restoring Swamp Conifers on Brushy Lowland Requires Adequate Brush Control, Large Stock, and Careful Planting

About 2-3/4 million acres of northern Minnesota lowland which once had valuable stands of spruce, tamarack, white-cedar, and balsam fir, are now occupied by worthless alder, willow, and other brush. The natural return of these conifers to such lands is a very slow process as few seed trees remain. To restore these lands to timber will therefore require planting.

Tests indicate that the brush competition on lowland areas can be reduced to a low level and the sites thus prepared for planting with aerial foliage sprays of 2,4-D. However, knowledge of swamp planting is limited. It therefore seems worthwhile to analyze the results of two planting trials on sprayed lowland in northern Minnesota.

One of these trials was put in near Craigville in spring 1953 with tamarack seedlings and with black spruce seedlings and transplants, the other near Loman with black spruce seedlings and transplants in October 1954, May 1955, and October 1955. In both areas, the trees were planted on sprayed and on unsprayed land.

Only the tamarack planted on sprayed land at Craigville shows fair survival and good average height, many of the trees being over 6 feet tall (table 1). In spite of these poor results, some definite conclusions can be drawn.

1. Survival and tree development at Craigville were better on sprayed than unsprayed land largely because tree mortality due to nipping by hares was less in the open areas. At Loman, however, hares came into the edges of the sprayed area from surrounding brush and caused more loss than in the unsprayed area.

2. Black spruce transplants gave much better survival and somewhat better growth than did the seedlings in both areas.

3. Important causes of mortality were hares, drowning, deep planting, and smothering by bluejoint grass. Severe nipping by hares also is responsible for most of the poor average height shown by the black spruce on both areas.

(over)

Table 1.--Survival and height of spruce and tamarack 4 to 7 years after planting

Species	Class of stock	Brush treatment	Average survival (percent)	Average height (feet)	Basis: No. of trees planted
		Craigville Area - 7 years after planting			
Black spruce	2-2	Sprayed	31	1.3	200
		Unsprayed	14	.7	50
Black spruce	2-0	Sprayed	12	1.0	200
		Unsprayed	2	.5	50
Tamarack	2-0	Sprayed	43	3.5	100
		Unsprayed	22	1.1	50
		Loman Area - 4 and 5 years after planting			
Black spruce	2-2 & 2-1	Sprayed	29	1.2	280
		Unsprayed	60	.8	20
Black spruce	3-0	Sprayed	23	1.0	180
		Unsprayed	35	1.0	20

On the basis of these results, further plantings after the spraying of similarly brushy peat lands should have a reasonable chance of success if the following precautions are taken:

1. Plant tamarack and transplant black spruce stock.
2. Plant on the hummocks avoiding low spots. Low spots may have standing water for long periods which will drown the trees.
3. Plant only when the surface peat is not frozen.
4. Black spruce is shallow rooted; do not plant it too deep.
5. Plant sprayed areas no later than the next spring.
6. Avoid grass areas until chemical or other control measures have been worked out for this important competitor.
7. Because of the possibility of hare nipping along the edges of sprayed areas, leave an unplanted buffer strip about 100 feet wide around all plantings.

July 1960

EUGENE I. ROE, Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 585

Top-Dying of Yellow Birch, Upper Michigan 1955-59

The progress of top-dying of yellow birch on the Upper Peninsula Experimental Forest at Dukes, Mich., has been observed since 1954. The proportion of injured trees was greater in 1959 than in any previous year. This is the third in a series of reports designed to keep those interested abreast of a changing situation affecting the most highly valued species in the northern hardwood timber type. Earlier observations are summarized in Technical Notes 444 and 527.

Foresters and loggers throughout the Upper Peninsula reported top-dying in 1959 not only of yellow birch but also of associated hardwoods. At Dukes the injury to other hardwoods was minor compared to that of yellow birch. The stands had 12 percent of all trees injured in 1958. This increased to 17 percent in 1959. In contrast, the survey showed 47 percent of the yellow birch trees with top-dying symptoms in 1958, and 68 percent in 1959. The increase in 1959 came after 2 consecutive years of improvement.

The observations during the last 3 years support the conclusion that top-dying is related to stand density (fig. 1). There was little difference in top-dying between stands until 1956. In that year the proportion of injured trees was greatest in heavily cut stands (less than 50 square feet of basal area per acre), somewhat less in moderately cut stands (50, 70, and 90 square feet of basal area), and least in the uncut area. This relationship has become more pronounced since 1956 with an injury gradient apparent also among the three densities in the moderately cut group.

The cause of top-dying is still undetermined. The injury first appeared in both the uncut and cut stands in 1954, the second growing season after logging. Weather conditions show no associations that account for both the initial top-dying and the increase of 1959. The determining factor could be a prolonged high water table during or just prior to the beginning of the growing season. According to records of the Wisconsin Michigan Power Company during 1949-57, this condition was present only in 1954.

Water table fluctuations have been recorded for the study area since 1957. The water table was within 1.5 feet of the ground surface until May 11 in 1959, but had subsided below this depth by May 3 during the 2 previous years. The prolonged period of high water in 1954 was more pronounced in that the decline did not begin until early June. Observations of water table levels during the spring of the year will be continued.

July 1960

RODNEY D. JACOBS
Research Forester

(over)

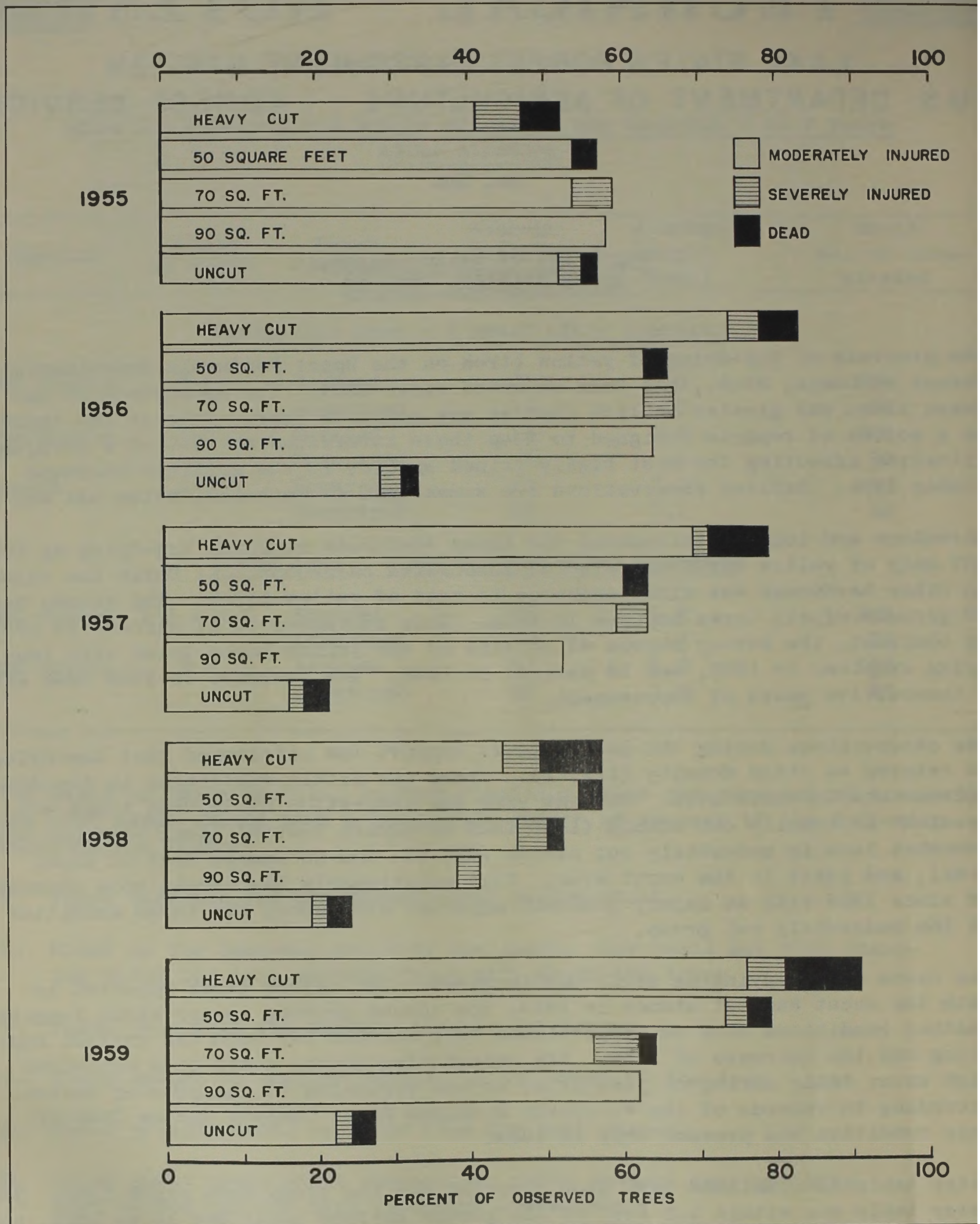

Figure 1.--Annual change in percent of yellow birch trees with top-dying, and severity of injury by intensity of cut. Severely injured trees have over one-half of the crown dead. Moderately injured trees have dead twigs or branches that constitute less than one-half the crown.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 586

Effect of Deer Browsing on a Young Jack Pine Plantation in Northern Lower Michigan

Surveys and general observations on deer browsing of jack pine in various parts of the Lake States have shown that damage has been widespread and severe in some areas. An example is a jack pine plantation near Curtisville in Alcona County, Lower Michigan, which has been under observation for 10 years.

This plantation of 64 acres was established in 1947 with 1,020 2-0 jack pine per acre. Excessive browsing by deer caused a loss of more than half of the seedlings and as a result the area was replanted in 1949. In that year a deer exclosure (40x40 feet) was established within the plantation. The young pine inside the exclosure and on a comparable unfenced plot were measured in 1949, 1951, 1954, and 1958.

Within a mile of the plantation are three browsed-out deer yards. The estimated deer population in the study area was 40 deer per square mile in 1940 and about 50 per square mile in 1950. The estimate for the years 1954 to 1957 was 20 to 30 per square mile, and in 1958 it was 30 to 50.

The results of the 10-year study show a loss of only one of the protected trees, whereas more than half of the trees subjected to deer browsing were killed (table 1). The fenced trees also grew more than twice as much in height. Inside the exclosure 22 of the 25 trees were classed as crop-quality trees. In contrast only 1 of the 7 unprotected trees was of crop quality; the rest were either multiple-stemmed or badly deformed by deer browsing.

Table 1.--Survival and average height of trees inside and outside deer exclosure

Year	Surviving trees		Average tree height in feet	
	Protected	Unprotected	Protected	Unprotected
1949	26	16	0.7	0.6
1951	26	11	1.9	.9
1954	26	10	5.1	3.4
1958	25	7	9.3	4.5

(over)

These results show that excessive deer populations are capable of killing many young planted jack pine up to the age of 10 years, retarding total height growth to one-half of its potential, and deforming most of the trees so that they have little future value for timber products.

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JOHN L. AREND, Forester
Lake States Forest Experiment Station

July 1960

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 587

High Growth Rate Maintained by 140-Year-Old Red Pine

The oldest active experiment of the Lake States Forest Experiment Station in northern Minnesota is a red pine thinning study on the Bena District of the Chippewa National Forest. Although originally a regeneration study, the experiment is now of interest principally because of the high sustained growth rate of the comparatively old red pine overstory. The experiment began in 1926 in a predominantly red pine stand then about 105 years old. The site index is 52 feet at age 50, which is about average for Minnesota.

The experiment consists of three plots, which have been thinned seven times in 33 years. The first thinning in 1926 reduced their basal areas to between 125 and 145 square feet per acre. The next six thinnings brought the basal area levels for each plot down lower. The average after thinning was 78 square feet per acre for plot 2 (range 70 to 91), 94 for plot 3 (range 88 to 106), and 120 for plot 4 (range 110 to 132). Plot 1 was clear cut in 1936 as part of the regeneration study.

The board-foot summaries for the 33-year period are given below:

Item	Board feet per acre, Scribner Decimal C log rule		
	Plot 2	Plot 3	Plot 4
Volume growth (1926-59)	16,440	16,760	15,620
Volume cut (1926-59)	21,480	22,920	20,520
Present volume (1959)	12,810	14,870	18,600

There is apparently little difference between the growth rates of any of the three stand densities used in this experiment. Plots 2 and 3 differ in growth by only 320 board feet in 33 years. Plot 4 has grown 1,140 board feet or 7 percent less than plot 3, which had the highest growth rate. Actually, the contrast in basal area density between any of the three plots is not great.

The most interesting aspect of the study has been the high sustained growth rates of this mature red pine. Plots 2 and 3 have averaged almost 500 board feet per acre per year for the past 33 years, while plot 4 has averaged 475 board feet. There has been no conspicuous decline in growth with advancing age. During the past 5 years the plots have grown an average of 440 board feet per acre per year.

(over)

Growth during the 33 years exceeds the present average standing volume of the three plots. It represents a fivefold increase over the growth that might have been predicted for the same span of years from a normal yield table.[1/] During this 33-year period almost 22,000 board feet of timber per acre have been harvested in the form of thinnings.

This experiment will be continued for some years to see how growth behaves in relation to advancing stand age. The results to date raise additional questions about what should be considered a proper rotation for red pine. This stand is now at the oldest age (140 years) commonly suggested for red pine rotations, and yet it is still growing well.

ROBERT E. BUCKMAN,
Research Forester

July 1960

1/ Eyre, F. H., and Paul Zehngraff. Red pine management in Minnesota. U.S. Dept. Agr. Cir. 778, 70 pp. 1948.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 588

Lake States Pulpwood Production Exceeds 3 Million Cords, 1959

Predictions have been made that the annual cut of pulpwood in the Lake States region would some day exceed 3 million cords. The breakthrough finally occurred in 1959 when approximately 3,019,000 cords of pulpwood were cut in the region (see table reverse side). The harvest was 15 percent larger than the previous year and about twice as much as that produced 10 years ago.

Each of the three Lake States showed an increase in production over the previous year. Michigan, for the first time in many years, was the region's leading pulpwood producing state, a place long held by Minnesota. The expansion of pulping capacity, especially in Michigan, and the use of larger proportions of local wood in Wisconsin were the factors largely responsible for bringing about the increase in production.

The 1959 cut of pine, aspen, white birch, and miscellaneous dense hardwoods was higher than in 1958. Pine, in particular, was cut more heavily for pulpwood than ever before. Plant residues found wider acceptance for use; most of it (chips) is shipped to Central States fiber mills, but four Lake States plants also use varying amounts.

Total 1959 pulpwood receipts at Lake States mills were nearly 3,400,000 cords, an increase of 9 percent from the previous year. Michigan receipts were up 27 percent, Minnesota 16 percent, and Wisconsin 1 percent. Local operators supplied about 88 percent of the pulpwood, Canada 10 percent, and western states 2 percent (see following table). Canadian imports were the lowest since the 1930's, dropping more than 30 percent in Wisconsin from the previous year.

Geographic origin and destination of pulpwood received by Lake States mills, 1959

Species	Percent of pulpwood originating from:					Percent of pulpwood received by:		
	Minn.	Wis.	Mich.	Canada	Other U. S.	Minn. mills	Wis. mills	Mich. mills
Aspen	28	32	38	2	-	30	46	24
Balsam fir	41	17	35	7	-	22	55	23
Birch	3	84	13	-	-	2	98	-
Hemlock	-	55	45	-	-	-	99	1
Pine	32	25	26	9	8	26	58	16
Spruce	38	4	14	42	2	23	61	16
Tamarack	53	33	14	-	-	16	84	-
Misc. hardwoods	1/ 5	2/ 61	2/ 34	-	-	5	64	31
All species	29	28	31	10	2	24	55	21
Previous year (1958)	29	26	29	14	2	22	60	18

1/ Balsam poplar (balm-of-Gilead).
2/ Mostly dense hardwoods.

A. G. HORN,
Research Forester

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

1959 production and imports of pulpwood, Lake States

(In standard cords, unpeeled)

Species and destination	Production by states[1]				Imports			Total receipts
	Minnesota	Wisconsin	Michigan	Region	Other U. S.[2]	Canada	Total imports	
Aspen								
Minn.	369,590	18,987	-	388,577	-	16,042	16,042	404,619
Wis.	11,712	409,094	197,959	618,765	-	-	-	618,765
Mich.	-	2,650	324,958	327,608	-	8,133	8,133	335,741
Total	381,302	430,731	522,917	1,334,950	-	24,175	24,175	1,359,125
Balsam fir								
Minn.	69,088	-	-	69,088	-	108	108	69,196
Wis.	52,615	52,063	63,704	168,382	-	320	320	168,702
Mich.	1,461	-	45,792	47,253	-	23,096	23,096	70,349
Exported[3]	6,843	-	-	6,843	-	-	-	-
Total	130,007	52,063	109,496	291,566	-	23,524	23,524	308,247
Birch, white								
Minn.	692	-	-	692	-	-	-	692
Wis.	254	26,117	3,909	30,280	-	-	-	30,280
Mich.	-	-	-	-	-	-	-	-
Total	946	26,117	3,909	30,972	-	-	-	30,972
Hemlock								
Minn.	-	-	-	-	-	-	-	-
Wis.	-	48,766	38,626	87,392	-	-	-	87,392
Mich.	-	-	532	532	-	-	-	532
Total	-	48,766	39,158	87,924	-	-	-	87,924
Pine								
Minn.	148,103	2,454	-	150,557	-	44,320	44,320	194,877
Wis.	91,231	184,153	80,113	355,497	56,051	24,487	80,538	436,035
Mich.	-	-	116,591	116,591	-	-	-	116,591
Exported[3]	91	-	-	91	-	-	-	-
Total	239,425	186,607	196,704	622,736	56,051	68,807	124,858	747,503
Spruce								
Minn.	118,465	-	-	118,465	-	9,537	9,537	128,002
Wis.	87,327	20,697	49,325	157,349	10,377	177,151	187,528	344,877
Mich.	5,725	-	33,658	39,383	-	54,472	54,472	93,855
Exported[3]	8,190	-	-	8,190	-	-	-	-
Total	219,707	20,697	82,983	323,387	10,377	241,160	251,537	566,734
Tamarack								
Minn.	3,156	-	-	3,156	-	-	-	3,156
Wis.	7,576	6,680	2,751	17,007	-	-	-	17,007
Mich.	-	-	-	-	-	-	-	-
Total	10,732	6,680	2,751	20,163	-	-	-	20,163
Misc. dense hdwds.								
Minn.[4]	12,346	-	-	12,346	-	-	-	12,346
Wis.[4]	-	155,587	9,707	165,294	-	-	-	165,294
Mich.[4]	-	-	80,759	80,759	-	-	-	80,759
Exported[3]	-	3,136	-	3,136	-	-	-	-
Total	12,346	158,723	90,466	261,535	-	-	-	258,399
Plant residues								
Minn.	-	-	-	-	-	-	-	-
Wis.	-	11,571	1,193	12,764	-	-	-	12,764
Mich.	-	-	905	905	-	-	-	905
Exported[3]	-	30,054	2,466	32,520	-	-	-	-
Total	-	41,625	4,564	46,189	-	-	-	13,669
All species								
Minn.	721,440	21,441	-	742,881	-	70,007	70,007	812,888
Wis.	250,715	914,728	447,287	1,612,730	66,428	201,958	268,386	1,881,116
Mich.	7,186	2,650	603,195	613,031	-	85,701	85,701	698,732
Exported[3]	15,124	33,190	2,466	50,780	-	-	-	-
Total	994,465	972,009	1,052,948	3,019,422	66,428	357,666	424,094	3,392,736

1/ Vertical columns of figures under box heading "Production by states" present the volume cut in each state.

2/ Mostly western states.

3/ Pulpwood shipped to mills outside of region.

4/ Balsam poplar (balm-of-Gilead) in Minnesota; mostly dense hardwoods in other states.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 589

Five-Year Results of a Growing-Stock Density Study in 85-Year-Old White Pine

If Eastern white pine (Pinus strobus) were free of blister rust (Cronartium ribicola) and white-pine weevil (Pissodes strobi), it would be the fastest growing conifer in the Lake States. An example of these high growth rates can be found in the 5-year results of a white pine growing-stock density study in an 85-year-old stand of white pine on the Pike Bay Experimental Forest near Cass Lake, Minn. The white pine is comparatively free of blister rust, and the trees are tall enough so that weevils cause no damage to the merchantable length of the bole.

The stand was released from overhead aspen, birch, and other hardwoods during the winter of 1933-34. Immediately after release there was a rapid acceleration of radial growth. This higher rate of radial growth has continued to the present time. How the early suppression affected height growth is not known, but the present height of dominants and codominants would indicate a site index of 55 feet (at age 50).

In 1954 the stand was divided into four parts, each part being cut to the following densities: 80, 100, 120, or 140 square feet of basal area per acre. Although the study has no formal replication, each stocking level is measured by six to eight 1/5-acre plots. In 1959 the stand was remeasured and each part again cut back to the assigned density.

Both the 1954 and 1959 cuts were essentially from below. In 1954 many suppressed and intermediate trees were removed; these had a high incidence of red rot (Fomes pini). By 1959 the cut was mostly in better intermediates and codominants. These trees were comparatively free of red rot; the exact proportion of defect was not measured but it was less than 5 percent of the total cut volume.

The growth rates in basal area and in board feet (with no deductions for defect) are given in the following table.

(over)

Table 1.--Effects of different stand densities on the 5-year growth rates of 85-year-old white pine

Basal area per acre (square feet)			Board-foot volume per acre[1/]		
When thinned	5 years later	Increase	When thinned	5 years later	Increase
81.0	95.4	14.4	13,170	16,500	3,330
97.8	115.2	17.4	15,900	19,920	4,020
121.3	137.8	16.5	19,730	23,840	4,110
138.1	157.0	18.9	22,450	27,160	4,710

1/ Scribner Decimal C log rule. Includes trees 7.6 inches d.b.h. and larger to a 6-inch top d.i.b.

The board-foot growth rates vary from 670 board feet per acre per year for the 80-square-foot density to 940 board feet for the 140-square-foot level. Although there is an apparent increase in growth rates with increased stand density, internal variation of the several 1/5-acre plots within each treatment would suggest little or no consistent difference between the 100-, 120-, or 140-square-foot levels. Although the 80-square-foot level shows less growth, further experimentation is needed for confirmation, for here again there is much internal variation of growth rates.

Normal yield tables for unmanaged white pine would suggest that this stand is already 10 to 20 years past the culmination of periodic board-foot increment. One can only speculate about how much higher the periodic annual increment would be in managed stands at the time of culmination. Likewise one must speculate about the rotation-long yield from such managed stands. But this small experiment and the rather limited amount of published material available indicate that in managed stands of white pine are found the highest growth rates of any of the northern conifers. The management possibilities of white pine are truly impressive when blister rust and white-pine weevils are not serious problems.

July 1960

ROBERT E. BUCKMAN, Research Forester
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TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 590

Two Cases of Wind Damage to Balsam Fir After Cutting

In 1957 a series of pilot plant cuttings were begun in northern Minnesota spruce-fir stands.1/ The principal objective was to test cutting as a means of controlling damage by the spruce budworm. Since the study was installed, two replications, one near International Falls and another near Grand Marais, experienced severe windstorms. An important consideration in the application of cutting practices in balsam fir stands is the susceptibility of this species to wind damage. The annual examinations of the sample plots for defoliation by the spruce budworm made it possible to pinpoint damage to particular storms, thereby relating damage to known wind velocity.

The timber at each location was about 50 years of age at breast height. Basal defect was relatively low. Each replication was made up of three treatments applied to blocks of 20 to 25 acres each. One block was a commercial clear cut, one was a partial cut, and the third area was left uncut.

The International Falls replication, 12 miles southeast of the airport Weather Bureau station, was cut early in 1957. On May 11, 1959, at 1:00 a.m. a severe storm with winds in excess of 30 miles per hour hit the area and continued until midafternoon on May 12. The wind started blowing from the south-southwest and shifted to the west-northwest. Maximum sustained velocity was 40 m.p.h. with gusts up to 58 m.p.h. Rainfall of 0.49 inch had fallen the day before.

The Grand Marais replication, 7 miles northeast of the U.S. Coast Guard weather station, was cut early in 1958. It is on the Lake Superior side of the continental divide but is about 1000 feet higher than the weather station. A severe storm started at 2:00 a.m. on November 18, 1958, and continued until 1:00 p.m. Sustained winds from the southwest of 64 m.p.h., with gusts up to 70 m.p.h., were recorded. Soil was softened during the 2-day period before the storm by 0.77 inch of rain.

Both storms occurred at a time when overstory hardwoods were not in leaf, so these trees probably offered little protection.

Trees destroyed by the storm were tallied on the 9 to 12 permanent 1/10-acre sample plots for each block. Uprooted and broken trees were not kept separate. Losses are shown in table 1.

1/ In cooperation with the Minnesota and Ontario Paper Company and the Superior National Forest.

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Table 1.--Balsam fir and spruce loss per acre, by kind of treatment.

Treatment		Number of trees lost		Basal area loss		
Kind	Percent of basal area cut	4- and 5-inch d.b.h.	6 inches d.b.h. and up	Trees 4 inches d.b.h. and up (sq. ft.)	Percent of all species	Percent of all spruce and fir
			INTERNATIONAL FALLS			
Check	0	0	4.4	1.48	1.5	2.2
Partial cut	27	3.0	14.0	5.73	7.4	11.2
Commercial clear cut	65	3.0	1.0	.55	1.9	5.7
			GRAND MARAIS			
Check	0	5.8	14.2	6.12	7.5	8.9
Partial cut	19	13.6	1/28.2	9.60	9.0	17.7
Commercial clear cut	43	2/29.0	1/23.0	8.30	10.2	34.9

1/ Includes 4.5 trees per acre of white spruce.
2/ Includes 1.0 tree per acre of white spruce.

In the uncut and partial-cut blocks the trees lost were principally balsam fir in the larger diameter classes. Those less than 6 inches d.b.h. made up the majority of trees lost in the commercial clear-cut blocks. The partial-cut block near International Falls suffered the highest loss on the west side, which had been exposed by adjacent cutting.

Any increased yields that might have been realized in these stands through partial cutting were probably lost by wind damage. However, this type of cutting may still be justified if damage by the spruce budworm is sufficiently reduced to offset the losses from wind. Continued observation will provide data on this problem.

H. O. BATZER
Entomologist

October 1960

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 591

Viability of Balsam Fir Seed Depends on Age of Tree

In a test of balsam fir seed collected in a good seed year, viability was related to tree age in trees from 40 to 155 years old. Germination of seed collected from younger trees varied considerably. These were the results of an experiment conducted in mixed coniferous swamps of the Upper Peninsula Experimental Forest in Michigan during the fall of 1958.

Prompt regeneration of mixed coniferous swamps is a major management problem. Although balsam fir reproduction is usually more abundant than that of other conifers in these swamps, even this species often fails to provide satisfactory stocking for many years after cutting.

The problem of securing adequate regeneration is frequently more difficult in overmature stands. One reason may be low viability of the seed from old trees (fig. 1). Balsam fir is considered mature at 70 years, but trees twice this age can be found in swamps. On these sites it is less susceptible to decay and continues growth much longer than on uplands.

Seed was collected from dominant and codominant trees. Five lots of 100 randomly selected seeds from each tree were stratified in moist sand for 90 days at 41° F. Actual germination was recorded for 40 days after sowing. At the end of the test the remaining seeds were cut open to count the number of sound seeds still ungerminated. The sound seed, plus the actual germinated seed, is the potential germination (fig. 1).

Actual germination of seed from trees around 30 years of age ranged from 4 to 46 percent. Another 4 to 13 percent of the seed were sound at the end of the test. Thus the potential germination ranged from 8 to 57 percent. This variation may indicate that trees of this age are just starting commercial seed production. However, Roe found a balsam fir that was producing some seed as early as 15 years of age.[1/]

The best results were obtained from seed of a 41-year-old tree. Actual germination was 63 percent and potential, 68 percent. Seed from older trees decreased in viability with tree age. Actual germination was only 3 percent and potential, 10 percent for a 155-year-old tree. The number of sound seed still ungerminated at the end of the test was not related to tree age.

The ability of balsam fir trees of different ages to restock an area will depend upon the amount of seed production as well as its viability. Total seed production in relation to age was not measured in this study.

October 1960

JOHN W. BENZIE
Research Forester

1/ Roe, Eugene I. Early seed production by balsam fir and white spruce. Jour. Forestry 46: 529. 1948.

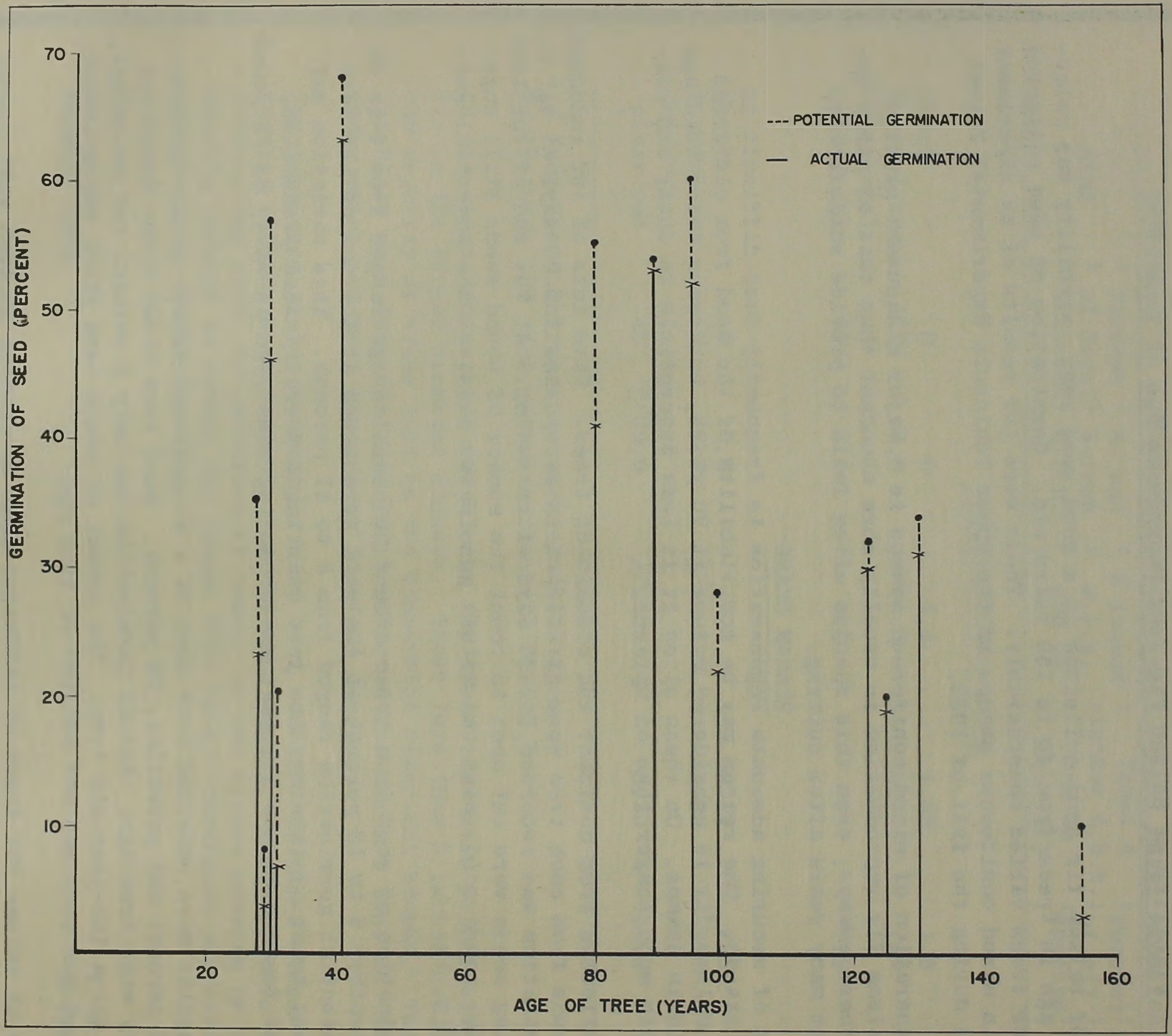

Figure 1.--Relationship of balsam fir seed germination to age of tree

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 592

European Pine Shoot Moth Damage Reduced on Sheared Christmas Trees

Removing the buds from the new growth of red and Scotch pines after late June can prevent 86 to 100 percent of the bud clusters that develop later on treated shoots from becoming infested with the European pine shoot moth (Rhyacionia buoliana (Schiff.)). Prevailing operations to shape pine Christmas trees correspond to this type of treatment, and therefore this cultural practice also prevents serious damage by the shoot moth.

In Lower Michigan most shoot moth eggs are laid by the last of June. The newly hatched larvae migrate upward on the shoots, feed briefly at the base of new needles, then move to buds into which they bore for further feeding. This movement takes place within a week or two after hatching. Normally, by mid-July or early August most of the larvae have entered buds. Access to buds is necessary for survival.

Since the new growth of many pine Christmas trees is cut back for shaping purposes during late June and July, with new buds developing later in the summer and fall, it seemed logical to expect that this practice would also reduce shoot moth infestations. Studies were carried out on red, Austrian, and Scotch pines in Lower Michigan from 1956 to 1959 to evaluate the effect of bud removal on infestations of this insect. Test clippings were done during three periods: (1) late June, (2) mid-July, and (3) early August.

Fifty sample trees, 3 to 6 feet in height, in each of two plantations showing infestation by the European pine shoot moth were used for statistical evaluation. The buds on the new growth of alternate trees were clipped off and left lying on the ground in a manner to simulate shaping operations.

The following spring the top 50 shoots on the Scotch pine and 25 top shoots each on the red and Austrian pine that were treated were examined for infestation along with an equal number of tips on each untreated tree. All the buds on both treated and untreated trees were also examined for total tree infestation to assess the effects of the treatment on total insect populations. The results and their standard deviations for the late June treatment on red and Scotch pine were as follows:

Species	Height class, feet	Percentage of Sample Shoots Infested: Clipped	Percentage of Sample Shoots Infested: Unclipped	Total No. of Insects: Treated trees	Total No. of Insects: Untreated trees
Scotch	6	3.6** ± 0.4	13.5 ± 1.2	4.3** ± 5.0	9.1 ± 8.6
Red	3	3.4** ± 0.3	15.2 ± 1.0	3.2** ± 2.9	7.1 ± 4.8

** Treatment significant statistically at 1-percent level.

(over)

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New shoots clipped in late June on the three pines studied developed a second bud cluster about 4 weeks later with a twofold increase in number of lateral buds. Late hatching larvae infested up to 14 percent of these bud clusters on Scotch and up to 8 percent on red pine. The average number was 3 to 4 percent. Less than 1 percent of the bud clusters developing after the mid-July treatment became infested, and none did after early August clipping.

After mid-July clipping, Scotch pine shoots developed buds in 4 to 8 weeks; a longer period was required for red and Austrian pines. These buds were slightly smaller, more numerous, and more scattered along the tip of the shoot than those following the first period. Often two buds formed in the terminal position. Buds forming on the shoots clipped in early August required 6 to 8 weeks and sometimes longer to develop on Scotch pine, and often did not develop until the following spring on red and Austrian pines. These buds were also small and scattered, and varied greatly in number.

These treatments produced no appreciable insect reduction on Austrian pine because of the low shoot moth populations that persisted each year on this species. Of the three pines studied, Austrian, a native of southern Europe, is the least susceptible and red pine the most susceptible.1/ Scotch pine is the species principally damaged in Europe.

The tips of shoots clipped off during late June, July, and early August and left on the ground contained no live larvae the following spring. The possibility of larvae moving back onto trees from these removed shoots is remote as shown by the less than 1-percent infestation of bud clusters obtained from treatments in July and early August when most of the larvae were on the tips that were removed.

The results of this study show that damage by the shoot moth can be greatly reduced when the new pine shoots are clipped after late June. An average of less than 3 to 4 percent of the bud clusters developing on these clipped shoots of pine was infested and destroyed by shoot moth. Although this type treatment also reduced the number of insects per tree by 50 percent, this reduction is not enough for adequate control of the insect.

These findings explain the reduction in shoot moth infestations commonly observed in pine plantings sheared regularly for Christmas trees. If shearing operations start when the pines are about 20 to 30 inches tall (usually about 3 years after planting) and are continued annually in late June and July until the growing season before harvest, damage to key portions of the tree can be prevented without expensive insecticidal treatment. Pine plantings having the heaviest shoot moth infestation should be treated last in the regular shaping operations to insure even more effective prevention from damage.

WILLIAM E. MILLER, Entomologist
JOHN L. AREND, Forester

October 1960

1/ Miller, W. E., and H. J. Heikkenen. 1959. The relative susceptibility of eight pine species to European pine shoot moth attack in Michigan. Jour. Forestry 57(12): 912-914.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 593

Residual Stand Density and the Early Development of Northern Hardwood Reproduction in Upper Michigan

The establishment of desirable reproduction is fundamental to the successful application of all-aged management in selectively cut northern hardwood stands. Although reproduction of tolerant species is often present in uncut stands, the seedlings need additional light for further growth. Seedling establishment and development can best be regulated by manipulating overstory density.

In 1951 the Lake States Forest Experiment Station began a stocking level study in the northern hardwood type of Upper Michigan. Variations in residual stand density were obtained by cutting to stocking levels of 30, 50, 70, and 90 square feet of basal area per acre in trees 10 inches d.b.h. and larger. These levels cover the range of residual stand density commonly observed in partially cut mature northern hardwood stands. Prior to cutting, the percentage species composition in the study area was as follows: sugar maple 77, yellow birch 14, beech 5, red maple 3, and other hardwoods 1.

Reproduction counts were made 2 and 5 years after the stand had been cut to the specified stocking levels. Seedlings were tallied in two size classes: class 1 for trees 6 to 35 inches tall, and class 2 for trees 3 feet tall to ½ inch d.b.h. Sprouts were combined with seedlings since they accounted for only 1 percent of the class-1 trees and 4 percent of the class-2 trees. Saplings 1 to 4 inches d.b.h. were also tallied to provide a complete picture of reproduction development.

Reproduction summaries showed that:

1. Sugar maple was the predominant species, accounting for about 90 percent of the seedlings and 75 percent of the saplings regardless of year of measurement. Yellow birch comprised 3 percent of the class-1 seedlings at 2 years and 8 percent at 5 years. But at both dates only 1 percent of the saplings and class-2 seedlings were yellow birch.

2. The density of the residual stand had no significant effect upon the total number of seedlings present at either 2 or 5 years after logging. There was, however, a significant increase in the number of seedlings under all densities during the 2- to 5-year period. Class-1 seedlings increased less than 25 percent, but class-2 seedlings increased as much as 170 percent (table 1). Similar increases in the percentage of quadrats stocked were also observed.

3. Residual overstory density had no significant effect on the percentage of quadrats stocked with sugar maple seedlings (table 2). However, the stocking of yellow birch seedlings was significantly greater in stands cut to 30 or 50 square feet than in stands with denser overstories.

4. The amount of sapling reproduction was not significantly affected by residual stand density (table 3).

This study showed that there was an increase in the number of seedlings and saplings from 2 to 5 years following logging. For yellow birch, residual stand densities of 30 and 50 square feet of basal area gave a greater increase in percentage of stocked quadrats than did denser overstories. Residual stand density had no effect upon the percentage of quadrats stocked with sugar maple, nor did it affect the total number of seedlings and saplings present at either measurement.

October 1960

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(over)

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--Summary of seedling reproduction 2 and 5 years after logging, by size class and residual stand density
(Thousands of trees per acre)

Years since logging	Size class1/	Stand density in square feet of basal area 30	50	70	90
2	1	26.6	26.7	27.9	21.5
	2	2.9	2.9	2.5	3.1
5	1	31.1	30.5	30.1	26.2
	2	6.0	7.8	6.8	4.6
Percent increase	1	17	14	8	22
	2	107	169	172	48

1/ Size class 1 - Seedlings 6 to 35 inches tall
Size class 2 - Seedlings 3 feet tall to ½ inch d.b.h.

Table 2.--Percentage of quadrats stocked with seedlings by species, size class, residual stand density, and years since logging

Species and size class1/	Stand density2/ 2 years after logging				Stand density2/ 5 years after logging			
	30	50	70	90	30	50	70	90
Sugar maple								
Class 1	86	86	90	82	91	88	96	89
Class 2	22	28	27	25	50	57	59	37
Red maple								
Class 1	6	5	6	12	8	7	9	14
Class 2	0	2	1	5	3	5	4	5
Yellow birch								
Class 1	10	11	4	7	25	24	9	19
Class 2	0	1	1	0	3	3	1	0
Beech								
Class 1	4	2	4	10	2	1	1	9
Class 2	3	1	1	6	5	1	2	8
Other hardwoods								
Class 1	5	4	6	5	4	2	5	4
Class 2	2	1	2	1	3	3	2	3

1/ Size class 1 - Seedlings 6 to 35 inches tall
Size class 2 - Seedlings 3 feet tall to ½ inch d.b.h.
2/ In square feet of basal area per acre

Table 3.--Summary of sapling reproduction 2 and 5 years after logging by tree size and residual stand density
(Number of trees per acre)

Diameter breast high (inches)	Years since logging	Stand density in square feet of basal area 30	50	70	90
1	2	90	52	81	101
	5	160	103	186	179
2	2	35	34	47	31
	5	55	44	55	39
3	2	20	16	21	27
	5	35	30	34	27
4	2	20	10	16	13
	5	10	12	14	16
Total	2	165	112	165	172
	5	260	189	289	261
Percent increase		58	69	75	52

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 594

Small Deer and Hare Exclosures Can Be Effective

Tests made on the Argonne Experimental Forest in northeastern Wisconsin show that small areas can be protected from deer browsing with low and relatively inexpensive fences. Seven exclosures 4 feet high and large enough to include a milacre sample plot showed no sign of entry by deer (Odocoileus virginianus) during 2 years following construction. These test exclosures were placed along regularly used deer trails in a cutover hardwood stand where the overall deer population averages approximately 25 per square mile. Tracks were observed around some of the exclosures following each snowfall during the first winter, but there was no indication that deer had been inside any of the fences.

The initial test included fences built in three different ways. Two types were built entirely in the field; the third was prefabricated and then assembled in the field. All were equally effective in excluding deer, but prefabrication appeared to be the most efficient method. A major portion of the job could be done in a shop where working conditions were favorable and tools readily available.

The prefabricated exclosure consists of four wire sides, each 4 feet high by 10 feet long, supported on a wooden framework. One side is made with stock wire, and the opposite side is made with poultry netting. The other two opposing sides are covered half with stock wire and half with poultry netting. The four sides are then taken into the field and assembled. The sharpened uprights are pushed into the ground and the corners fastened with wire. A piece of poultry netting is fastened across the middle to make one half of the exclosure hareproof leaving the other half open to hares. See back of sheet for details of construction.

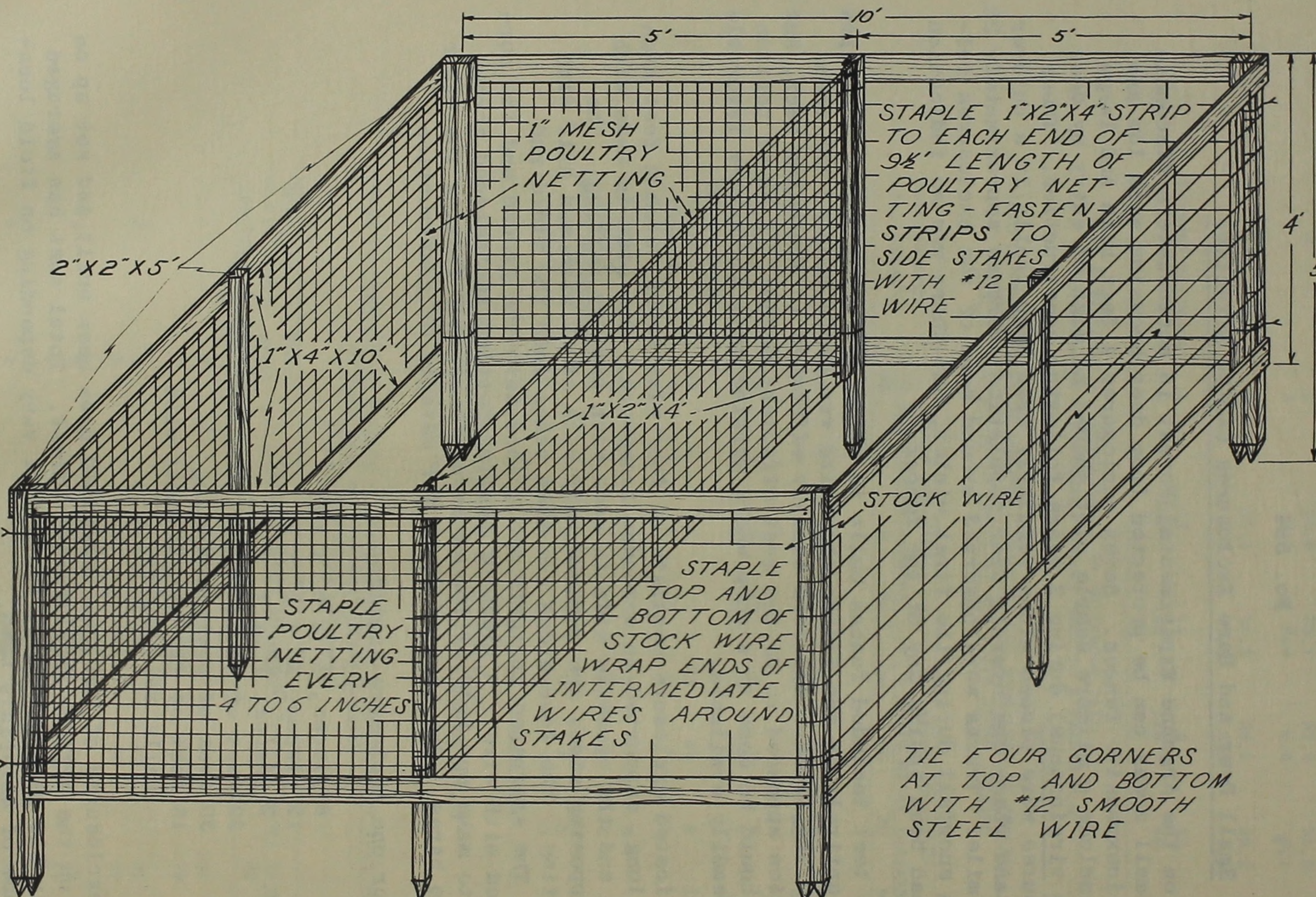
Materials for one exclosure include:

8 pieces, 1" x 4" x 10'
12 pieces, 2" x 2" x 5'
2 pieces, 1" x 2" x 4'
22 feet of stock wire
30 feet of poultry netting
15 feet of #12 smooth steel wire
nails and staples

Thirty-two exclosures of the type described have been built and set up on study plots on the Argonne Experimental Forest. Total cost has averaged approximately $10 per exclosure. This will vary depending on field location and grade of materials used.

January 1961

JOHN H. COOLEY
Research Forester



DETAILS OF EXCLOSURE CONSTRUCTION

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 595

Jack Pine From Lake States Seed Sources Differ in Susceptibility to Attack by the White-Pine Weevil

During the 1953 and 1954 growing seasons 17 jack pine seed source plantations were established in the three Lake States.[1/] The plantations consist of four replications of a randomized block design, each replication with 30 seed sources. Sixty-four trees of 2-0 stock from each source were set out in 40-foot square blocks with a 5x5-foot spacing. One of these plantations was established on the Chippewa National Forest near Cass Lake, Minn. Measurements of this plantation in August 1958 (fifth year) showed that as high as 23 percent of the trees of a seed source were found to be currently damaged by the white-pine weevil. This afforded an opportunity to study susceptibility of seed sources to damage by this pest.

Preliminary analysis of the 1958 attacks revealed a highly significant difference between seed sources. To obtain stronger evidence the plantation was examined again during August 1959. The data for 1958 and 1959 were combined and subjected to an analysis of variance. Appropriate precautions were taken to insure additivity and homogeneity of variance. The analysis of variance is as follows:

Source of variation	Degrees of freedom	Mean squares
Replications	3	1.05**
Seed sources	29	1.11**
Error	87	.22
Total	119	

**Significant at the 1-percent level.

Table 1 shows a comparison between sources for mean numbers of trees weeviled per acre per year. Significantly more weeviling occurred in the sources from Pine County, Minn.; Douglas, Burnett, Marinette, Oneida, and Wood Counties, Wis.; and Gogebic County, Mich., than was observed in the local source. No source had significantly less damage than the local stock. The basic cause for the difference is obscure, but it is believed to be some characteristic of these trees. It is also possible that these sources planted elsewhere may respond differently to other weevil populations. Further investigation is necessary before the responsible factors are known.

It is apparent that considerable care should be exercised when selecting seed for planting stock, even within the natural range of jack pine. Over the entire rotation of these trees it will be difficult to evaluate the growth characteristics of the different seed sources that are due to genetic differences because weeviling may mask them.

January 1961

H. O. BATZER
Entomologist

1/ "Work plan for a regional jack pine seed source study in the Lake States" by Paul O. Rudolf and T. Schantz-Hansen, July 7, 1953; on file at the Lake States Forest Experiment Station.

(over)

Table 1.--Mean number of trees weeviled per acre per year during 1958 and 1959. Chippewa National Forest plantation, regional jack pine seed source study.

State and county of origin	Seed source number	Mean no. of trees weeviled per acre per year
MINNESOTA		
Cass	1589	34.4
Cass	1590	32.5
Itasca	1591	26.3
Lake	1592	33.5
Cook	1593	36.7
St. Louis	1594	35.8
Pine	1595	125.6**
Pine	1596	114.1**
Becker	1597	48.2
Cass	1600	47.1
Beltrami	1601	30.2
Itasca	1602	49.8
Cass	Local	33.5
WISCONSIN		
Douglas	1604	99.1**
Bayfield	1605	12.1
Forest	1606	50.9
Oneida	1607	60.3
Burnett	1608	97.6**
Marinette	1609	114.1**
Oneida	1610	108.5**
Wood	1611	116.5**
MICHIGAN		
Gogebic	1612	104.5**
Ontonagon	1613	47.1
Alger	1614	56.1
Chippewa	1615	60.3
Manistee	1616	44.9
Ogemaw	1617	56.1
Alpena	1618	63.3
Grand Traverse	1620	30.8
Luce	1621	32.1

**Significant at the 1-percent level when compared with local source.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 596

Grasshoppers--A Major Defoliator of Trees and Shrubs in the Northern Great Plains

Several species of grasshoppers are found in the Northern Great Plains. Fundamentally, the species in the eastern or crop-producing area (to which this discussion is confined) differ from those in the western part where the cover is principally range grass.

Figure 1.--Heavy grasshopper defoliation of a Siberian peashrub in a shelterbelt adjacent to a freshly harvested field.

The predominant species in the eastern part of North Dakota and South Dakota are Melanoplus bivittatus, M. bilaturatus, M. packardii, M. femur-rubrum, and M. differentialis. Their normal food hosts are many and include alfalfa, small grains, soybeans, flax, and corn. Grasshoppers have a long history as destructive agents in this region, and extensive survey and control programs have been carried on to prevent crop loss.

Trees and shrubs, as well as crops, have been extensively damaged in the Plains since the shelterbelt plantings of the 1930's, especially in dry and drought years. Since grasshoppers are general feeders, any or all species of trees and shrubs in the shelterbelts may be attacked. Even conifers like ponderosa pine are not immune.1/

In years of heavy grasshopper populations, entire belts may be completely denuded. One complete defoliation of the deciduous trees may not always kill the trees, but when the twigs, buds, and bark are also chewed off, mortality occurs and a belt can be wiped out. Of course, one complete defoliation of a conifer is sufficient to kill it.

In 1960, which was a reasonably wet year by Plains standards, grasshopper populations were relatively low and consequently damage to shelterbelts was light. The shrubs planted in the outer rows of belts, particularly the Siberian peashrub (Caragana arborescens), were most damaged (fig. 1).

1/ George, E. J. Thirty-one-year results in growing shelterbelts on the Northern Great Plains. U.S. Dept. Agr. Cir. 924, 57 pp., illus. 1953.

Complete rows of Caragana were seldom severely defoliated, and only an occasional plant was lightly debarked. Slight grasshopper feeding also occurred on boxelder, American elm, Russian olive, plum, willow, honeysuckle, and hackberry in various belts, as well as on several species of weeds between the rows of trees.

Shelterbelts adjacent to cornfields always had lighter populations than those next to grainfields. Once the corn and grain had been harvested, however, the grasshoppers in those fields migrated to and concentrated on the trees and shrubs.

To prevent damage to a shelterbelt, a farm owner should examine his crops just prior to harvest to determine the grasshopper population. This is especially important in drought years when populations are apt to be high. Control, if necessary, is most feasible while the insects are still feeding in the fields. One method of preventing damage would be to leave a narrow strip of the crop adjacent to the shelterbelt unharvested. Then, poison bait or an insecticide could be applied on the strip to kill the migrating grasshoppers before they reach the trees.

January 1961 LOUIS F. WILSON, Entomologist

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 597

Mortality and Top Killing of Spruce-Fir Caused by Repeated Budworm Defoliation

Beginning in 1955, annual surveys have followed the spread of the spruce budworm infestation of the spruce-fir type in northern Minnesota. In 1958, a new color variation was observed in some of the stands: They appeared gray instead of the brown usually found in heavy infestations. Investigation showed that these stands were not only sustaining heavy current feeding, but also had had heavy to complete defoliation for at least the previous 2 years. This condition, classed as severe defoliation, has intensified and increased in area each succeeding year. In 1960, 96,000 acres of spruce-fir type were mapped as severely defoliated.

Until this past season quantitative data on tree condition, such as top killing and tree mortality, were lacking, primarily because most of the severe defoliation was located in the remote canoe country where travel is restricted to canoe or float-equipped airplanes.

During the last week in September of 1960 a three-man crew traveled 185 miles by canoe across the border country and established eight paired plots in spruce-fir type to determine the volume of timber losses attributable to budworm defoliation. To reduce bias, the route was mapped from an airplane prior to the trip, and the areas of severe defoliation were noted. This information was transferred to timber survey maps, and approximate plot locations were chosen. Criteria for selection of a plot pair were that both plots had to be located in similar timber types and in contiguous forest stands. The circular plots varied in size from 1/7 acre to 1/3 acre, depending on tree density. Each plot had to be large enough to provide a sample of at least 80 susceptible trees 4 inches d.b.h. and larger.

All trees were tallied that (1) had a dead top of 2 or more feet or (2) had died within the past 2 years. Top killing was determined by binocular examination. Tree death was verified by examining the cambium. Dead trees were studied to discover whether they had been killed by the budworm. If the cause of death could not be ascribed to the budworm, the tree was tallied as having been killed by other causes.

Individual plot data revealed top killing as high as 78 percent and tree mortality as great as 2.4 cords per acre. The volume of each budworm-killed tree was based on the diameter at breast height and an estimate of the number of 100-inch sticks to a 3-inch top. These values, as shown in table 1, were converted to cordwood volume per acre by diameter classes.

Trees under 4 inches d.b.h. were tallied on one-quarter of the plot, the northwest quarter being arbitrarily chosen on all plots. Of these smaller trees, 6.5 percent were top killed, 11.9 percent were dead because of budworm defoliation, and an additional 8.9 percent mortality was due to other causes.

Many of the top-killed trees are now very near death. The fate of all the trees will be followed to determine trends in the deterioration of spruce-fir following a budworm epidemic.

January 1961

D. C. SCHMIEGE, Entomologist

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--Top killing and tree mortality in areas heavily infested by spruce budworm, 1960[1/]

DBH (inches)	Species	Total trees on plots	Percent of trees top killed	Percent of trees killed by -- Budworm	Other causes	Cdwd. vol./acre of budworm-killed trees
4	Balsam fir	334	22.5	6.0	5.4	0.024
	W. spruce	4	0	0	25.0	0
5	Balsam fir	367	34.9	6.8	4.1	.081
	W. spruce	5	0	20.0	0	.005
6	Balsam fir	217	48.4	4.6	3.7	.106
	W. spruce	7	0	0	0	0
7	Balsam fir	111	53.2	15.3	1.8	.262
	W. spruce	4	0	0	0	0
8	Balsam fir	56	66.1	8.9	5.4	.133
	W. spruce	6	0	16.7	0	.021
9	Balsam fir	18	72.2	5.6	11.1	.034
	W. spruce	8	0	0	0	0
10	Balsam fir	13	100.0	0	0	0
	W. spruce	11	0	9.1	0	.060
11	Balsam fir	12	83.3	0	8.3	0
	W. spruce	4	0	0	0	0
12	Balsam fir	9	100.0	0	0	0
	W. spruce	0	0	0	0	0
13	Balsam fir	6	83.3	16.7	0	.094
	W. spruce	2	0	0	0	0
14 & up	Balsam fir	2	100.0	0	0	0
	W. spruce	8	0	0	0	0
Average per acre		364	37.9	6.9	4.1	.821

1/ Based on 16 plots of variable size totaling 3.31 acres. Plots are located in northern Minnesota.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 598

1960 Forest Tree Seed Crop Generally Good in the Lake States

During 1960, forest tree seed production in general was the best since 1950, and second best for the 15 years of record, according to observations made at field centers of the Lake States Forest Experiment Station (see table on reverse side). Except in North Dakota one or more species produced bumper crops in each locality of the region, although seed production generally was best in northeastern Wisconsin and central Upper Michigan. Compared to 1959, production was better in all sections of the region.

In northern Minnesota, bumper crops were reported from some localities for white spruce, black spruce, balsam fir, northern white-cedar, and paper birch. Most of the other species had fair to good crops, although failures were reported locally for red pine, eastern white pine, and tamarack.

Bumper crops for white spruce, northern white-cedar, basswood, and yellow birch were reported in northeastern Wisconsin. All other species had good crops in that section except red pine (fair) and black ash (poor).

White spruce, balsam fir, eastern hemlock, sugar maple, and yellow birch produced bumper crops in central Upper Michigan. All other species had fair to good seed crops.

In Lower Michigan seed production generally was poorer than in other parts of the Lake States, although bumper crops were produced by eastern white pine and balsam fir and good crops by red pine, sugar maple, and black cherry. All other species had fair to poor crops except white oak (failure).

In north-central North Dakota boxelder, green ash, Russian-olive, and caragana produced good seed crops. Hackberry and bur oak had crop failures, and the other species reported had poor to fair seed production.

Because most seed collectors are interested primarily in the pines and spruces, 1960 should be considered a good year. It was a favorable year for providing seed for natural regeneration of most of our important forest tree species. For those wildlife species dependent upon mast 1960 also was a good year except in Lower Michigan and North Dakota.

April 1961 PAUL O. RUDOLF, Research Forester

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--Forest tree seed crops in the Lake States, 1960

Species	Estimated percentage of a full crop[1] in--				
	Northern Minnesota	Northeastern Wisconsin	Central Upper Michigan	Lower Peninsula Michigan	North-central North Dakota
Red pine	7-25	50	75	75	[2] -
Eastern white pine	7-75	75	50	95	-
Jack pine	50-75	75	-	50	-
Ponderosa pine	-	-	-	-	25
White spruce	50-95	95	95	50	-
Black spruce	50-95	75	75	50	-
Norway spruce	-	75	-	-	-
Balsam fir	50-95	75	95	95	-
Eastern hemlock	-	75	95	50	-
Northern white-cedar	50-95	95	75	50	-
Tamarack	7-50	-	-	25	-
Sugar maple	50-75	75	95	75	-
Red maple	-	75	75	25	-
Boxelder	-	-	-	-	75
American beech	-	-	50	25	-
Basswood	50	95	50	50	-
Yellow birch	75	95	95	-	-
Paper birch	50-95	75	-	50	-
Quaking aspen	50	75	-	25	-
Bigtooth aspen	50	-	-	25	-
American elm	-	75	75	25	25
Siberian elm	-	-	-	-	25
Hackberry	-	-	-	-	7
White ash	-	75	-	50	-
Green ash	75	-	-	-	75
Black ash	75	25	50	-	-
Bur oak	50	-	-	-	7
Northern pin oak	75	-	-	25	-
Black oak	-	-	-	50	-
Northern red oak	75	75	75	25	-
White oak	-	-	-	7	-
Black cherry	-	-	-	75	-
Chokecherry	-	-	-	-	50
American plum	-	-	-	-	25
Russian-olive	-	-	-	-	75
Caragana	-	-	-	-	75

1/ Percentage of a full crop classified as 0-15, failure; 16-35, poor; 36-60, fair; 61-90, good; and 91-100, bumper.

2/ A dash (-) signifies no report on this species.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE
No. 599

Calculating Volume Loss in Balsam Fir Pulpwood from Wood-Boring Insects

Studies conducted in northern Minnesota revealed that over 95 percent of the long-horned beetles (Cerambycidae) attacking balsam fir pulpwood were species of *Monochamus*. The larvae of these beetles, when young, feed upon the inner bark, cambium, and outer sapwood of weakened or dead trees and pulpwood, and form shallow excavations called surface galleries (fig. 1-A). As the larvae grow older, however, each bores a deep tunnel from its surface gallery into the heartwood. The oval-shaped entrance holes (fig. 1-B) to the tunnels are conspicuous and easily recognized when the bark is removed.

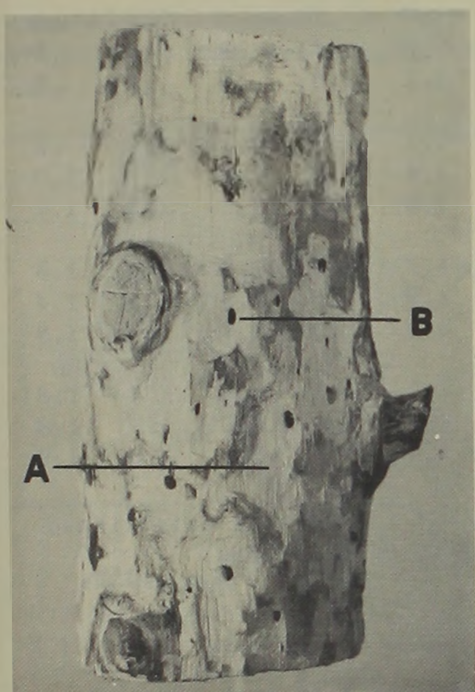


Figure 1.--Section from balsam fir bolt showing: A, surface galleries; B, entrance hole to tunnel.

Seventy pulpwood sticks were examined after the insects had emerged, to determine the volume loss from *Monochamus* feeding. The volume loss in each stick was calculated by a method devised by the author[1/]. The number of insects that had been present was determined by counting the number of entrance holes. A graphic analysis showed a good correlation between the number of entrance holes per stick and the percent volume loss per stick. The calculated regression line of this graph was used to derive table 1.

It must be stressed that volume loss varies directly with the amount of insect feeding (i.e., the more the insect feeds the more damage it causes). To get maximal volume loss, only those sticks should be examined in which insect feeding has terminated. Since studies have shown that *Monochamus* spp. need about 23 months to develop in the northern United States and southern Canada[2/], examinations should be made on sticks that have been cut at least two seasons prior to the time of sampling (i.e., sticks examined in the fall of 1961 must have been cut no later than midsummer of 1960; sticks examined in the spring of 1961 must have been cut no later than midsummer of 1959). When this criterion has been established, volume loss may be calculated as follows:

1/ Wilson, L. F. Insect damage to field-piled pulpwood in northern Minnesota. Unpublished manuscript in files of Lake States Forest Experiment Station. 1961.

2/ Belyea, R. M. Death and deterioration of balsam fir weakened by spruce budworm defoliation in Ontario. Part I: Notes on the seasonal history and habits of insects breeding in severely weakened and dead trees. Canad. Ent. 84: 325-35. 1952.

(Over)

Table 1.--Percent volume loss from Monochamus borings for various sized pulpsticks determined by the number of entrance holes per stick[1].

Number of entrance holes per 100" stick	Average diameter of balsam fir stick (inches)												
	3	4	5	6	7	8	9	10	11	12	13	14	15
5	.4	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1	.1	.1
10	.7	.5	.5	.4	.3	.3	.3	.3	.3	.2	.2	.2	.2
15	1.0	.8	.6	.5	.5	.4	.4	.3	.3	.3	.3	.3	.3
20	1.3	1.0	.8	.7	.6	.5	.5	.5	.4	.4	.4	.3	.3
25	1.6	1.2	1.0	.8	.7	.6	.6	.5	.5	.5	.4	.4	.4
30	1.9	1.4	1.2	1.0	.9	.8	.7	.7	.6	.5	.5	.5	.4
40	2.5	1.9	1.5	1.3	1.1	1.0	.9	.8	.7	.7	.6	.6	.6
50	3.1	2.3	1.9	1.6	1.4	1.2	1.1	1.0	.9	.8	.8	.7	.7
60	3.7	2.8	2.3	1.9	1.6	1.4	1.3	1.2	1.1	1.0	.9	.9	.8
70	4.2	3.3	2.6	2.2	1.9	1.7	1.5	1.4	1.2	1.1	1.1	1.0	.9
80	4.9	3.7	3.0	2.5	2.1	1.9	1.7	1.5	1.4	1.3	1.2	1.1	1.0
90	5.5	4.1	3.0	2.8	2.4	2.1	1.9	1.7	1.6	1.4	1.3	1.2	1.2
100	6.1	4.6	3.7	3.1	2.7	2.3	2.1	1.9	1.7	1.6	1.5	1.4	1.3
110	6.7	5.0	4.1	3.4	2.9	2.6	2.3	2.1	1.9	1.7	1.6	1.5	1.4
120	7.3	5.5	4.4	3.7	3.2	2.8	2.5	2.3	2.1	1.9	1.8	1.6	1.5
130	7.9	5.9	4.8	4.0	3.4	3.1	2.7	2.4	2.2	2.0	1.9	1.8	1.6
140	8.5	6.4	5.1	4.2	3.7	3.3	2.9	2.6	2.4	2.2	2.0	1.9	1.8
150	9.1	6.7	5.5	4.6	4.0	3.5	3.1	2.8	2.5	2.3	2.2	2.0	1.9

1/ Values over 5 percent were calculated on the basis of the pattern established for the lower values, but no observations on losses were made in this area.

1. The bark should be removed from the samples.

2. The number of entrance holes and the average diameter (inches) of each 100-inch stick should be recorded.

3. The values from step 2 are used in table 1. The resultant number in the table gives an approximate percent volume loss for 100-inch pulpsticks.

Samples can be examined in the field or in the pulpyard, and those in the yard may be sent through the debarker prior to counting entrance holes. The number taken for samples may vary, but several sticks should be examined to get an average volume loss. Two or three sticks per cord will suffice if a small pile is sampled, while one stick per 1 or 2 cords is enough for large yard piles. As a general rule, a 100-stick sample will give an estimate within one-half of one percent. It should be noted that sticks on the outside of the piles are more vulnerable to attack by wood borers than those on the interior. Therefore both exterior and interior sticks should be sampled in proportion to their numbers.

April 1961

LOUIS F. WILSON, Entomologist

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 600

More Forest Land in the Northern Lake States?

The northern Lake States region, consisting of 94 counties stretching across northern Michigan, Wisconsin, and Minnesota, has been in transition from forest to agriculture and vice versa since the first white pine here fell before a logger's axe (fig. 1). The sweep of logging across the region opened up lands which, at the time, were judged to be fine opportunities for agricultural settlement and development. Agricultural economists during the 1920's carried on intensive studies of the patterns, problems, and possible solutions of agricultural development in this area, and even as recently as the 1930's commercial agriculture was considered to hold considerable promise on these northern lands.[1]

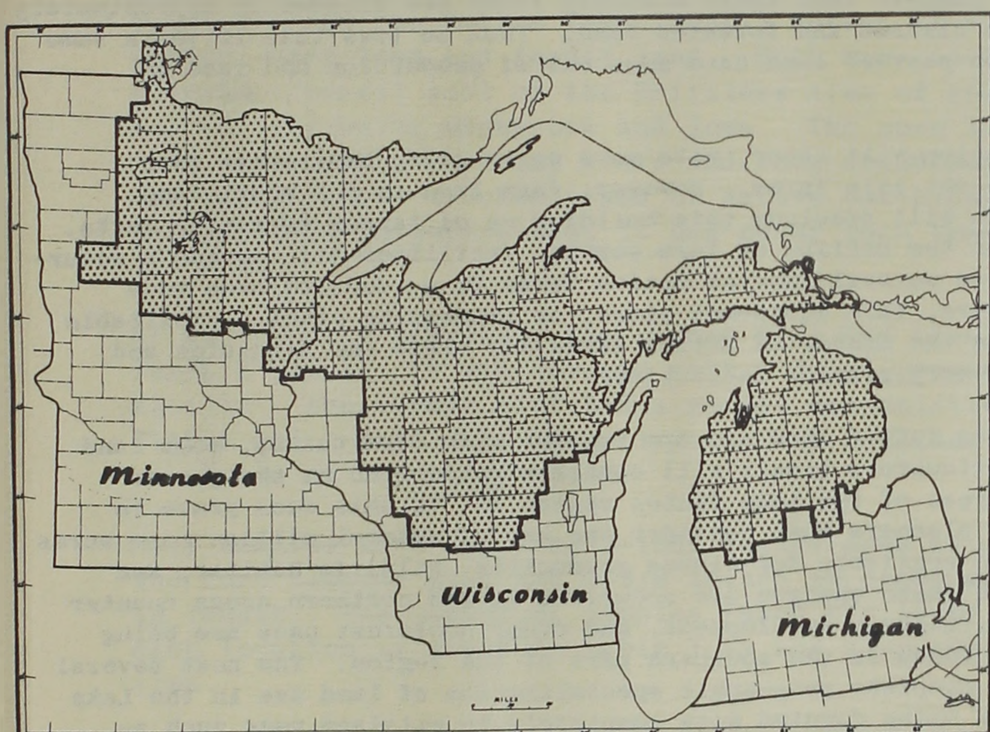


Figure 1.--Location of 94 counties included within the area referred to as the Northern Lake States.

However, examining the trend in number of active farms and their acreage in the northern Lake States now gives cause to speculate that, whereas at one time the forest was giving way to the plow, the reverse now seems to be true. Data from the past several Censuses of Agriculture show striking declines in farming as a land use in the northern Lake States (fig. 2).

1/ For instance, see: J. D. Black and L. C. Gray, Land Settlement and Colonization in the Great Lakes States, (U.S. Dept. Agr. Bul. 1295, 1925); and W. A. Hartman and J. D. Black, Economic Aspects of Land Settlement in the Cut-over Region of the Great Lakes States (U.S. Dept. Agr. Cir. 160, 1931).

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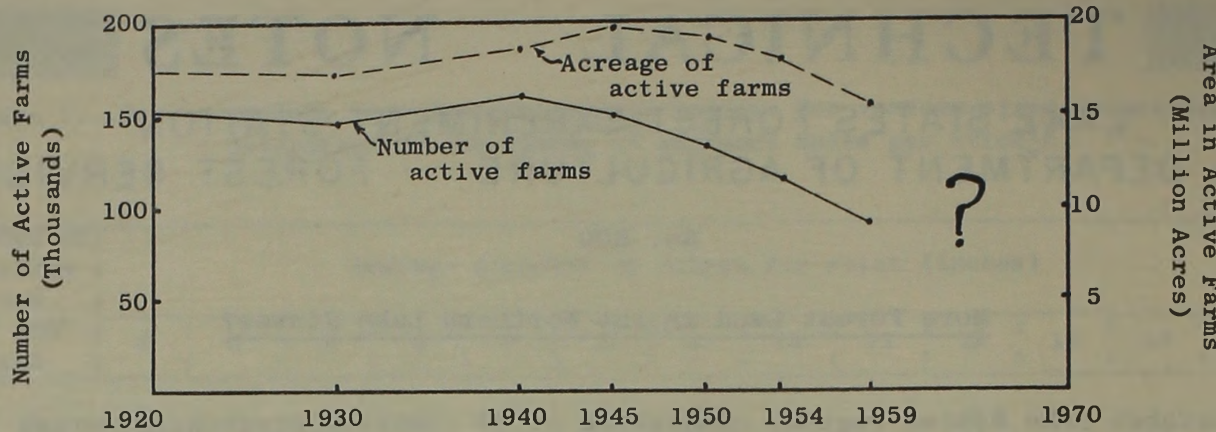

Figure 2.--Trend in the number of active farms in the Northern Lake States, 1920-1959.

Recently, the Soil Bank program undoubtedly has influenced some farmers, particularly older operators, to leave farming in these northern counties. However, the Soil Bank program was initiated late in 1956, and the trend away from farming was evident before this date.

What will become of the lands included in these farm units? The Census of Agriculture shows that almost 3,600,000 acres of farm holdings moved out of farm use between 1950 and 1959. This includes cropland and pasture as well as existing farm woodlands. Averages from Census data suggest that these northern farms are divided in approximately a 60:40 proportion between cleared and forested land. Thus in less than 10 years some 2,160,000 acres of crop and pasture land have gone out of production and face an uncertain future.

Undoubtedly some consolidation will occur, with more aggressive, prosperous farm operators taking over adjacent idle farms. However, farm land is not mobile and economics of location often will preclude this building up of larger operating units. Also in many northern areas the decline of farm service facilities will impede a resurgence of agriculture. Where several hundred active farms in a locality once made the operation of a feed store, farm equipment store, or processing plant a profitable enterprise, the decrease in the number of active farms may alter the situation and cause a loss of these necessary service facilities.

While predictions concerning future land use are fraught with uncertainty, some land economists suggest that agriculture likely will continue to decline on the poorer soils and less adaptable areas of the Lake States region.[2] If this does prove to be the case, then resource planners must consider the use of several million more acres of land which could be made available for timber production, wildlife habitat, and recreation. However, while these changes are occurring in the northern areas counter inroads of urban expansion, highway development, and other nonforest uses are being made on presently forested lands in the southern part of the region. The next several decades may produce a more complete geographic specialization of land use in the Lake States, with northern areas being devoted more completely to wildland uses such as forestry and recreation while southern areas continue to feel the pressures of expanded urbanization and associated service uses.

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[2] Marion Clawson, R. Burnell Held, and Charles H. Stoddard, Land for the Future (Baltimore: Johns Hopkins Press, 1960), p. 459. Also see: Willard W. Cochrane, "An Economist Looks at Northeastern Minnesota", The Future of Minnesota's Resources, 1958, Report of the Governor's Second Conference on State Resources (St. Paul, Office of Iron Range Resources and Rehabilitation, 1958), p. 218.

April 1961

DEAN N. QUINNEY
Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 601

Comparison of Bulk Density of Soil in Abandoned Land and Forest Land

Bulk density is an important indicator of the water relations of soils. Low bulk density signifies a porous condition usually associated with high infiltration and high detention of water. Within a single soil type, this factor is influenced by the amount of macro-pore space and organic matter. These in turn are influenced largely by land use.

Bulk density measurements were taken under two different land-use conditions on the Coulee Experimental Forest in southwestern Wisconsin--open land and forest land. Both were on Dubuque silt loam, a common loessal soil of the Driftless Area of southwestern Wisconsin and adjoining Minnesota and Iowa. The open land had been used as a farm garden for many years and then abandoned. The forest land was a moderately stocked stand of native oak-hickory sawtimber. As far as could be determined, it has never been trampled by domestic animals.

At the time of sampling, the garden plot had been abandoned for at least 2 years. It was covered with a dense growth of grasses and alfalfa. The forest plot had a normal accumulation of hardwood leaf litter and a duff-mull humus layer about 2 inches thick. Both are on slopes of about 5 percent.

Soil samples were taken by 3-inch layers down to a 24-inch depth; the core sampler used was 2-3/8 inches in diameter by 2-3/4 inches in length. The number of samples taken per layer in each plot at each location is given in table 1 as are also the mean bulk densities.

The much lower bulk density in the surface (0- to 3-inch) layer under forest cover has been frequently observed by others; it is due to the accumulation of forest humus. The surface 0 to 3 inches is often considered the critical horizon in watershed management research. It is interesting, however, that the plowed area, which was subsequently abandoned, showed a lower bulk density in the 3- to 9-inch zone than did the forested area. This is probably the result of plowing and later invasion by grass and alfalfa.

April 1961

RICHARD S. SARTZ, Research Forester

Table 1.--Bulk densities and differences on forest and open-land plots, by depth classes

Depth class (inches)	Number of samples		Mean bulk density		
	Open	Forest	Open	Forest	Difference
0 - 3	12	12	1.08	0.70	0.38**
3 - 6	12	12	1.07	1.22	.15**
6 - 9	12	8	1.26	1.36	.10
9 - 12	12	8	1.40	1.37	.03
12 - 15	8	8	1.44	1.43	.01
15 - 18	8	8	1.48	1.46	.02
18 - 21	8	8	1.54	1.49	.05*
21 - 24	8	8	1.56	1.52	.04

**Difference is significant at the 1-percent level.

*Difference is significant at the 5-percent level.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 602

Insect Damage to White Spruce Cones and Seeds-- A Factor in White Spruce Regeneration

White spruce, one of the most valuable conifers in the Lake States area, normally produces a heavy crop of seeds every 2 to 6 years, and lighter crops in between. Natural regeneration, as well as development of adequate nursery stock, is influenced greatly by seed production during these heavy cone-bearing years. Therefore, any insect injury that reduces the quantity of seed, particularly in good crop years, also affects natural and artificial regeneration.

Many insects feed directly upon the seeds. Others feed on the very young cones, thereby preventing or curtailing normal seed development. Some of the hollow and aborted seeds often found in cones may be caused by insect injury to the young ovules.

Figure 1.--*Laspeyresia* sp. larva in white spruce cone. Note damaged seeds.

In 1960, a prolific seed year for white spruce, quantities of cones were collected in the Lake States. Samples from collections made by the Kimberly-Clark Paper Company in Minnesota and Michigan, were examined and rated according to the presence or absence of insects or insect damage. All insects found were tentatively identified and an estimate was made of the extent of the injury (table 1).

The following insects, obtained from the samples, are discussed briefly.

Laspeyresia sp. (fig. 1). The larva of this moth was the most common and most destructive in the samples. As the larva matures, it bores down the rachis of the cone and feeds on the adjoining seeds. The larval tunnel and the hollowed seedcoats are characteristically packed with frass. Damage to seeds by this insect has been reported as high as 100 percent during poor cone years, but damage is generally about 25 percent.

Pegohylemyia sp. Infested cones frequently have more than one maggot of this fly attacking the seeds. The small exit hole is the only apparent external evidence of the insect's presence. Internal damage, however, is readily recognized by the resin and frass-filled tunnels between the scales. The seeds are generally entirely consumed, but a few seedcoat remnants may be found.

Table 1.--Percentage of white spruce cones examined within each county that were damaged by insects

Insects involved	State and county								
	Minnesota		Michigan						
	St. Louis	Lake	Alger	Chippewa	Dickinson	Gogebic	Iron	Marquette	Ontonagon
Laspeyresia	4	12	0	4	10	14	16	8	4
Pegohylemyia	3	2	0	0	3	10	2	8	12
Dasyneura	20	8	0	0	1	0	6	0	0
Megastigmus	0	0	0	0	4	7	0	0	0
Rubsaamenia	0	0	4	0	0	0	0	4	0
Unknown borer	7	4	8	0	0	4	0	2	0
Unknown	3	4	0	4	0	7	2	2	0
Total	37	30	12	8	18	42	26	24	16
Basis: no. of cones examined	100	25	50	25	78	28	50	50	51

Dasyneura sp. The maggot of this midge was quite common in the samples, but was credited with little or no damage to the seeds. The eggs are laid under the scales at the base of the cone when the scales open to receive the pollen. Upon hatching, the young larvae bore into the cone and feed within the rachis. Although seed damage may be slight, a secondary effect may occur from the weakening of the bored stem which could cause premature drop of the cone.

Megastigmus sp. This small chalcid was found only in the cones from Michigan. The larva feeds entirely inside the seedcoat, completely destroying the developing seed. The number of seeds destroyed in any one cone is variable.

Rubsaamenia sp. The maggot of this midge normally feeds on the resin found within the cones and apparently does little damage. However, heavily infested cones may produce a number of aborted seeds.

Choristoneura fumiferana (Clem.), spruce budworm. The larva of the spruce budworm causes considerable damage by feeding on the developing cones. This feeding not only destroys some of the seed in the cones attacked, but also distorts the growth of the cone, thereby reducing the quantity of seed produced. Since this damage cannot be easily distinguished from some other surface-feeding insects, it has been listed in the table under unknown.

Unknown borer. Feeding by this insect was characterized by the presence of webbing containing a considerable amount of frass. From the appearance of the cone at the time of attack, it is doubtful that the insect concerned is the budworm. Only the seeds within the excavated area were destroyed. Damage occurred too late in the development of the cone to cause cone deformity.

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Kimberly-Clark of Michigan, Inc.

April 1961

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 603

Intensity of Soil Moisture Sampling Is Affected by Depth and Vegetative Cover[1/]

Soil scientists, agriculturists, and foresters who study soil moisture behavior are faced with a common sampling problem: How many samples are required to give a reasonable estimate of moisture available for plant growth?

This is a complex problem since several factors contribute to differences in soil moisture. One is physical variations in the soil itself. Another is cover. Different cover types affect soil moisture because of the varying size of plants and root systems, which not only affect distribution of precipitation but withdrawal of moisture from the upper soil horizons.

To measure soil moisture changes in a relatively uniform sandy soil profile (Grayling sand in Lower Michigan), a number of soil samples were collected for moisture content under oak cover and in an adjacent open field supporting grass cover. Both study areas, about 1 acre each in size, were sampled at the end of the growing season when the soil moisture was near the wilting point (September 1957) and at the beginning of the growing season when soil moisture was near field capacity (April 1958).

The soil moisture variation under grass and oak as determined by 40 sampling points is shown in table 1. Sampling points were selected systematically at ½-chain intervals (33 feet). Inches of moisture are given for the 0-1, 1-2, 2-3, 3-5, and 5-7 foot depths at each sampling point. Moisture contents were determined gravimetrically in the laboratory and converted to inches of water.

Under both cover types, soil moisture variability as expressed by standard deviation showed a general decrease with increasing depth. In the grass plot the surface foot had less variability than the second foot of soil. This may be a result of the uniform occupation of the surface soil by grass roots as compared to a patchy root distribution and variable humus depth in the oak.

Variations in soil moisture are slightly less under grass than forest cover for each depth sampled in both the wet and dry periods. Again, this may be attributable to the more uniform root distribution in grass cover.

It is only reasonable to point out the statistical limitations of this study. Only one plot in each cover type was sampled, and samples were taken only under extremes of wetness and dryness. The variation that may be expected in other plots and under other ranges of soil moisture may be different.

1/ This study is one phase of a watershed research project being conducted in cooperation with the Michigan Department of Conservation.

The results indicate that the number of samples needed for an estimate of soil moisture will vary by soil depth and cover crop. Under both cover types more samples are needed in the upper horizons. An oak plot should be more intensively sampled than a grass plot to achieve the same reliability of measurement. Figure 1 indicates that in the first foot of soil about twice as many samples are needed under oak as under grass. At the 5-7 foot depth, only a 25-percent increase in sampling intensity is required.

April 1961 WILLIAM D. STRIFFLER, Research Forester

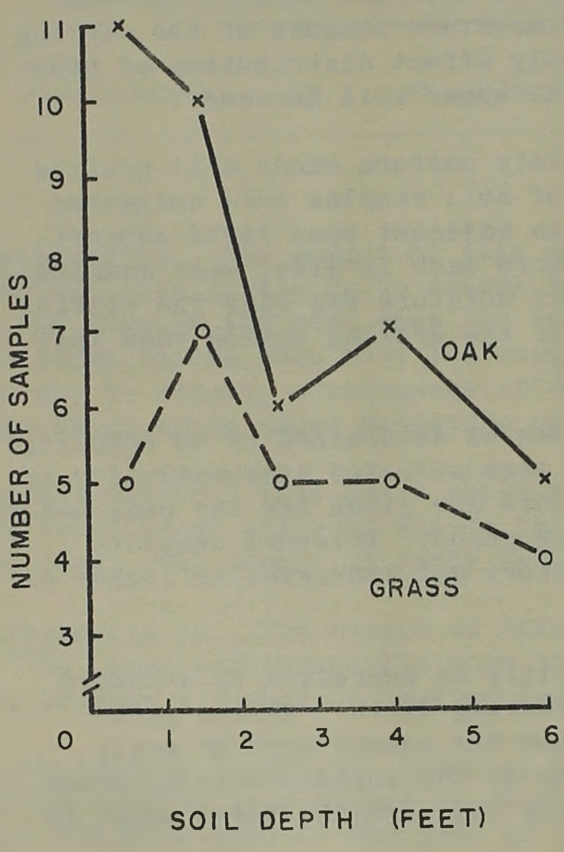

Figure 1.--Sampling frequency adjusted by soil depth to give soil moisture within 0.09 inch of accuracy per foot of soil.

Table 1.--Soil moisture variation under grass and oak during wet and dry periods; measured at 40 sampling points on 1-acre study areas for each type of vegetation
(In inches of water)

Soil depth (feet)	Mixed oak		Grass	
	Mean	Standard deviation	Mean	Standard deviation
May 8 (wet period)				
0-1	1.37	0.15	1.14	0.09
1-2	1.05	.14	1.03	.12
2-3	.78	.11	.76	.08
3-5	.74	.07	.71	.06
5-7	.72	.09	.77	.08
September 19 (dry period)				
0-1	.64	.13	.86	.08
1-2	.43	.11	.43	.12
2-3	.28	.09	.33	.10
3-5	.34	.12	.51	.11
5-7	.40	.10	.56	.09

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 604

Current Timber Growth Estimates for the Lake States

Forest Survey estimates show that annual net cubic-foot timber growth in the Lake States increased 38 percent between 1936 and 1956 (table 1).[1/] Sawtimber growth rose even more rapidly, expanding by 92 percent. Increased growth was associated with a general improvement in stocking and a high rate of ingrowth as more small trees reached merchantable size. This sizable increment occurred even though commercial forest area in the region declined by 1.2 million acres. More advances in total growth can be expected if planting continues to mount and mortality losses are reduced.

Table 1.--Estimated current annual growth of all growing stock (sawtimber plus cordwood) and of sawtimber in the Lake States, 1936 and 1956.

Growth of growing stock in million cubic feet

Species Group	1936	1956	Percent increase
Pine	88	105	+ 19
Other softwoods	120	196	+ 63
Northern hardwoods	106	135	+ 27
Aspen-cottonwood	301	352	+ 17
Other hardwoods	238	389	+ 63
All species	853	1,177	+ 38

Growth of sawtimber in million board feet (International 1/4" Rule)

Species Group	1936	1956	Percent increase
Pine	258	407	+ 58
Other softwoods	213	441	+ 107
Northern hardwoods	253	324	+ 28
Aspen-cottonwood	178	487	+ 174
Other hardwoods	509	1,046	+ 106
All species	1,411	2,705	+ 92

Pine and aspen cubic-foot growth increased about half of the average for all species. In contrast other softwoods and other hardwoods species groups expanded increment by over 60 percent. In these groups balsam fir, red maple, elm, and the ashes were mainly responsible for the sizable rise in growth.

Increased growth of sawtimber is largely in species not commonly preferred for sawlogs. For example, while pine and northern hardwoods had increases well below the average for all species, aspen sawtimber growth nearly tripled. Sawtimber growth of other hardwoods doubled, primarily because of higher growth of elm, soft maple, and the oaks.

1/ Although nominally dated 1956, the estimates in this paper were compiled from Forest Surveys completed in 1953 in Minnesota, 1957 in Michigan, and 1958 in Wisconsin. The 1936 estimates were adjusted to be comparable with the new estimates. The 1956 data supersede those presented in Technical Note No. 452, which were based on partial results of Forest Surveys in Wisconsin and Michigan and complete results in Minnesota.

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Table 2.--Current annual net timber growth in the Lake States, 1956

Species	Lake States	Minnesota	Wisconsin	Michigan
Growth of growing stock in million cubic feet				
White and red pine	45.6	15.1	11.9	18.6
Jack pine	59.9	15.1	12.1	32.7
Spruce	49.0	27.7	5.7	15.6
Balsam fir	77.7	37.7	10.4	29.6
Hemlock	9.4	-	2.6	6.8
Tamarack	22.0	13.3	2.8	5.9
Cedar	37.3	8.7	3.9	24.7
All softwoods	300.9	117.6	49.4	133.9
Sugar maple	78.9	5.9	22.2	50.8
Yellow birch	9.8	.3	3.6	5.9
Beech	5.2	-	.6	4.6
Basswood	41.0	13.2	14.1	13.7
Oak	120.5	28.6	45.5	46.4
Elm	56.9	11.7	14.1	31.1
Aspen	352.0	147.0	96.5	108.5
Paper birch	59.5	24.7	14.2	20.6
Soft maple	59.3	1.3	17.2	40.8
Ash	41.4	15.4	11.7	14.3
Other hardwoods	51.3	18.9	10.4	22.0
All hardwoods	875.8	267.0	250.1	358.7
All species	1,176.7	384.6	299.5	492.6
Growth as a percent of growing stock volume	4.6	5.3	3.8	4.6
Growth of sawtimber in million board feet (Int. 1/4" Rule)				
White and red pine	207.6	67.4	60.0	80.2
Jack pine	199.5	83.9	27.6	88.0
Spruce	111.3	57.6	10.6	43.1
Balsam fir	161.8	78.2	17.4	66.2
Hemlock	49.0	-	17.1	31.9
Tamarack	35.8	22.3	4.3	9.2
Cedar	82.5	19.3	13.9	49.3
All softwoods	847.5	328.7	150.9	367.9
Sugar maple	141.3	9.5	50.0	81.8
Yellow birch	27.8	1.2	11.5	15.1
Beech	26.8	-	3.0	23.8
Basswood	128.8	41.7	44.7	42.4
Oak	425.0	96.8	187.3	140.9
Elm	234.8	47.1	61.5	126.2
Aspen	486.7	170.4	169.7	146.6
Paper birch	67.2	23.7	16.9	26.6
Soft maple	113.7	.8	30.6	82.3
Ash	93.5	36.0	26.6	30.9
Other hardwoods	112.1	32.2	25.3	54.6
All hardwoods	1,857.7	459.4	627.1	771.2
All species	2,705.2	788.1	778.0	1,139.1
Growth as a percent of sawtimber volume	5.1	6.3	4.8	4.8

July 1961

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TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 605

Season of Logging Unimportant in Creating Disturbed Seedbeds for Yellow Birch

For effective seedling establishment, yellow birch requires a disturbed seedbed where mineral soil is present. It has often been suggested that sufficient seedbed scarification could be obtained by logging during the summer. The normal practice, however, is to harvest yellow birch and associated species during the winter when the ground is snow covered. But just how much scarification can be expected from logging selectively marked stands with different snow depths present?

To answer this question, the Lake States Forest Experiment Station began a study in Upper Michigan in 1957 to observe the effects of season of logging upon seedbed disturbance. The results were obvious: Summer logging provided greater scarification than did fall or winter logging. But the important point is that, except for skidways, disturbed seedbeds occurred on only 17 percent of the area even with no snow present. Furthermore, only 10 percent of the area was considered suitable for the establishment of yellow birch.

This study was established in an old-growth stand in the hemlock-yellow birch type. The principal species were eastern hemlock, yellow birch, sugar maple, and red maple. The site was flat and wet, which made logging more difficult during summer than winter.

Two replications were established, each containing three rectangular 5-acre plots. The timber on each of these plots was selectively marked to leave a thrifty residual stand of 90 square feet of basal area per acre in trees over 9.5 inches d.b.h. Except for one heavily stocked plot the gross volume cut ranged from 2600 to 3600 board feet per acre and averaged 3000 board feet.

In each replication one 5x10-chain plot was logged in the fall when the snow depth averaged 5 inches. Another was logged in the winter when the average snow depth was 18 inches. The remaining plot in each replication was harvested in the summer. Logs were ground-skidded with an HD-5 tractor to a skidway located at the narrow end of each 5-acre plot.

Sampling transects were placed at 1-chain intervals perpendicular both to the long axis of the plot and to the direction of skidding. Each square foot along these transects was examined after logging and placed in one of the following categories:

1. Moss	5. Live tree
2. Hardwood leaf	6. Hardwood leaf disturbed
2a. Conifer leaf	8. Fresh bolt or stump
3. Grass or sedge	9. Mixed mineral soil and organic matter (50-50)
4. Bark or sawdust	10. Mineral soil

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Although seedbed classes 6, 9, and 10 were disturbed by logging, only classes 9 and 10 were considered favorable for the establishment of yellow birch. Table 1 shows that acceptable birch seedbeds occurred on only 2 percent of the area in winter-logged plots, on 6 percent of the area in fall-logged plots, and on 10 percent of the area for plots logged in the summer. Skidways were excluded from these computations because of the great disturbance caused by decking the logs.

Table 1.--Proportion of total seedbed disturbed by logging during different seasons

Seedbed type	Fall, snow depth 5"	Winter, snow depth 18"	Summer, no snow
	Percent	Percent	Percent
(6) Disturbed leaf	3.8	3.4	7.6
(9) + (10) Mixed organic and mineral, or mineral soil	5.9	1.8	9.6
(6) + (9) + (10) Total disturbed seedbed	9.7	5.2	17.2

From this study it is evident that season of logging affects seedbed disturbance, but insufficient scarification is obtained from logging regardless of the season in which it is done. If our aim is to enhance the establishment of yellow birch, we should rely on specific treatments for seedbed disturbance rather than on logging. A similar recommendation was made following a study of logging scarification in the Northeast.[1/] The slight increase in favorable seedbeds obtained by summer logging is not worth the extra troubles associated with logging moist sites at this season.

July 1961

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1/ Marquis, David A., and Bjorkbom, John C. How much scarification from summer logging? U.S. Forest Serv., Northeast. Forest Expt. Sta., Forest Res. Note 110, 3 pp., illus. 1960.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 606

Lake States Pulpwood Production Up 11 Percent in 1960

The 1960 harvest of pulpwood in the Lake States was 3,337,000 cords, 11 percent larger than the previous high of 3,019,000 cords attained in 1959.

Each of the three Lake States registered a rise in production over the previous year. The increase in Michigan was most impressive: almost 20 percent. Following the pattern established during the previous year, Michigan continued to be the leading pulpwood-producing State in the region, accounting for 37 percent of the total cut. Minnesota and Wisconsin each accounted for 31½ percent.

Stepped-up production of aspen and softwood species (except pine), contributed to the heavier cut of pulpwood. Aspen registered the largest gain with a cut 20 percent higher than that of the previous year. Michigan increased its aspen cut 28 percent and Wisconsin 25 percent. The cut of miscellaneous dense hardwoods, which has been increasing each year, registered only a modest gain in 1960. Michigan's cut of these species was less than that of the previous year.

Lake States mills procured wood-chips and other plant residues in amounts about equal to those of 1959. On the other hand, exports of wood-chips to other States dropped off sharply, declining 39 percent.

Total 1960 pulpwood receipts at Lake States mills were nearly 3-3/4 million cords, an increase of 9 percent from the previous year. Michigan and Wisconsin receipts were up 16 percent and 12 percent, respectively, while those of Minnesota were down about 3 percent. Lake States forests supplied 89 percent of the pulpwood received, Canada 9 percent, and western States 2 percent (see following table).

Geographic origin and destination of pulpwood received by Lake States mills, 1960

Species	Percent of pulpwood originating from:					Percent of pulpwood received by:		
	Minn.	Wis.	Mich.	Canada	Other U. S.	Minn. mills	Wis. mills	Mich. mills
Aspen	24	33	41	2	-	25	48	27
Balsam fir	39	14	39	8	-	24	51	25
Birch	3	73	24	-	-	3	85	12
Hemlock	-	53	47	-	-	-	98	2
Pine	33	18	28	9	12	24	57	19
Spruce	40	3	18	39	-	19	65	16
Tamarack	65	19	16	-	-	9	91	-
Misc. hardwoods	1/3	2/70	2/27	-	-	3	74	23
Slabs, veneer cores, etc.	-	99	1	-	-	-	100	-
Chips	-	65	17	-	18	-	100	-
Total	28	28	33	9	2	21	57	22
Previous year (1959)	29	28	31	10	2	24	55	21

1/ Balsam poplar (balm-of-Gilead). 2/ Mostly dense hardwoods.

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July 1961

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Production and imports of pulpwood, Lake States, 1960

(In standard cords, unpeeled)

Species and destination	Production by states[1/]				Imports			Total receipts
	Minnesota	Wisconsin	Michigan	Region	Other U.S.[2/]	Canada	Total imports	
Aspen								
Minn.	379,239	17,680	-	396,919	-	11,321	11,321	408,240
Wis.	12,604	522,519	249,905	785,028	-	93	93	785,121
Mich.	-	176	419,034	419,210	-	11,362	11,362	430,572
Total	391,843	540,375	668,939	1,601,157	-	22,776	22,776	1,623,933
Balsam fir								
Minn.	82,884	-	-	82,884	-	1,687	1,687	84,571
Wis.	51,204	50,093	74,843	176,140	-	177	177	176,317
Mich.	-	82	60,140	60,222	-	25,334	25,334	85,556
Exported[3/]	11,330	-	-	11,330	-	-	-	-
Total	145,418	50,175	134,983	330,576	-	27,198	27,198	346,444
Birch, white								
Minn.	1,029	-	-	1,029	-	-	-	1,029
Wis.	50	26,803	4,286	31,139	-	-	-	31,139
Mich.	-	-	4,668	4,668	-	-	-	4,668
Total	1,079	26,803	8,954	36,836	-	-	-	36,836
Hemlock								
Minn.	-	-	-	-	-	-	-	-
Wis.	-	51,924	44,722	96,646	-	-	-	96,646
Mich.	-	-	1,845	1,845	-	-	-	1,845
Total	-	51,924	46,567	98,491	-	-	-	98,491
Pine								
Minn.	124,731	832	-	125,563	-	38,164	38,164	163,727
Wis.	100,239	123,010	59,399	282,648	80,155	24,950	105,105	387,753
Mich.	-	-	128,214	128,214	-	-	-	128,214
Total	224,970	123,842	187,613	536,425	80,155	63,114	143,269	679,694
Spruce								
Minn.	110,853	-	-	110,853	-	5,462	5,462	116,315
Wis.	128,000	18,322	60,794	207,116	163	181,870	182,033	389,149
Mich.	19	24	47,692	47,735	-	46,292	46,292	94,027
Exported[3/]	17,497	-	-	17,497	-	-	-	-
Total	256,369	18,346	108,486	383,201	163	233,624	233,787	599,491
Tamarack								
Minn.	2,612	-	-	2,612	-	-	-	2,612
Wis.	15,956	5,573	4,608	26,137	-	-	-	26,137
Mich.	-	-	-	-	-	-	-	-
Total	18,568	5,573	4,608	28,749	-	-	-	28,749
Misc. dense hdwds.								
Minn.[4/]	10,056	-	-	10,056	-	-	-	10,056
Wis.[4/]	-	198,016	9,719	207,735	-	-	-	207,735
Mich.[4/]	-	-	65,485	65,485	-	-	-	65,485
Exported[3/]	-	5,550	-	5,550	-	-	-	-
Total	10,056	203,566	75,204	288,826	-	-	-	283,276
Roundwood, total								
Minn.	711,404	18,512	-	729,916	-	56,634	56,634	786,550
Wis.	308,053	996,260	508,276	1,812,589	80,318	207,090	287,408	2,099,997
Mich.	19	282	727,078	727,379	-	82,988	82,988	810,367
Exported[3/]	28,827	5,550	-	34,377	-	-	-	-
Total	1,048,303	1,020,604	1,235,354	3,304,261	80,318	346,712	427,030	3,696,914
Slabs, veneer cores, etc.								
Minn.	-	-	-	-	-	-	-	-
Wis.	-	6,338	90	6,428	-	-	-	6,428
Mich.	-	-	-	-	-	-	-	-
Exported[3/]	-	47	-	47	-	-	-	-
Total	-	6,385	90	6,475	-	-	-	6,428
Chips								
Minn.	-	-	-	-	-	-	-	-
Wis.	-	5,239	1,379	6,618	1,405	-	1,405	8,023
Mich.	-	-	-	-	-	-	-	-
Exported[3/]	-	19,498	335	19,833	-	-	-	-
Total	-	24,737	1,714	26,451	1,405	-	1,405	8,023
All wood material								
Minn.	711,404	18,512	-	729,916	-	56,634	56,634	786,550
Wis.	308,053	1,007,837	509,745	1,825,635	81,723	207,090	288,813	2,114,448
Mich.	19	282	727,078	727,379	-	82,988	82,988	810,367
Exported[3/]	28,827	25,095	335	54,257	-	-	-	-
Total	1,048,303	1,051,726	1,237,158	3,337,187	81,723	346,712	428,435	3,711,365

1/ Vertical columns of figures under box heading "Production by States" present the amount of pulpwood cut in each state.

2/ Mostly western states.

3/ Pulpwood shipped to mills outside of region.

4/ Balsam poplar (balm-of-Gilead) in Minnesota, mostly dense hardwoods in other states.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 607

Stand Density Influences Stem Taper in a Thinned Red Pine Plantation

In a red pine plantation thinning experiment under way in Lower Michigan since 1951, diameter increment at 4.5 feet and 17.0 feet was measured to determine the effects of stand density on taper in the first log. Although growth at both 4.5 and 17.0 feet decreased with increasing basal area density, the changes in stem taper were relatively small over broad ranges of stand density (fig. 1). Stem taper was about the same at 100 and 140 square feet of basal area, but at 60 square feet it increased and at densities above 140 square feet per acre it decreased.

This thinning study was established in 1951 in a 43-year-old red pine plantation initially spaced at 4x5 feet. Basal area at the first thinning averaged 200 square feet per acre. Total height and height to live crown averaged 38 and 19 feet, respectively. Densities from 60 to 160 square feet per acre were established in 2-acre compartments which were marked to leave the highest quality trees regardless of crown class. In 1956 each compartment was rethinned to the designated basal area.

In 1960 changes in stem taper based on growth at 4.5 and 17.0 feet were measured on 9 potential sawtimber trees in each of the thinned compartments and the unthinned area. Diameter growth at breast height was computed from the periodic measurements. Radial growth inside the bark at 17 feet was measured on increment borings and doubled to obtain the diameter increment. Differences in diameter growth at breast height and 17 feet were taken to indicate changes in stem form. The test was limited to individual tree growth and does not include total growth and value per acre.

The fastest diameter growth at both 4.5 and 17.0 feet was obtained at the lowest density of 60 square feet per acre. At this stand density, growth at 4.5 feet was 20 percent greater than at 17.0 feet, resulting in increased stem taper.

As stand density increased from 100 to 140 square feet, diameter growth decreased at both 4.5 and 17.0 feet at about the same rate. At 200 square feet per acre, diameter growth at 17 feet exceeded that at 4.5 feet during the 8-year study period and thereby decreased butt log taper. This trend, of course, cannot be expected to continue indefinitely.

In this study and period of measurement, basal area densities of 60 to 100 square feet provided the most rapid stem increment in the first log with only slight increase in taper. Whether this trend continues with increasing age still remains to be determined.

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July 1961

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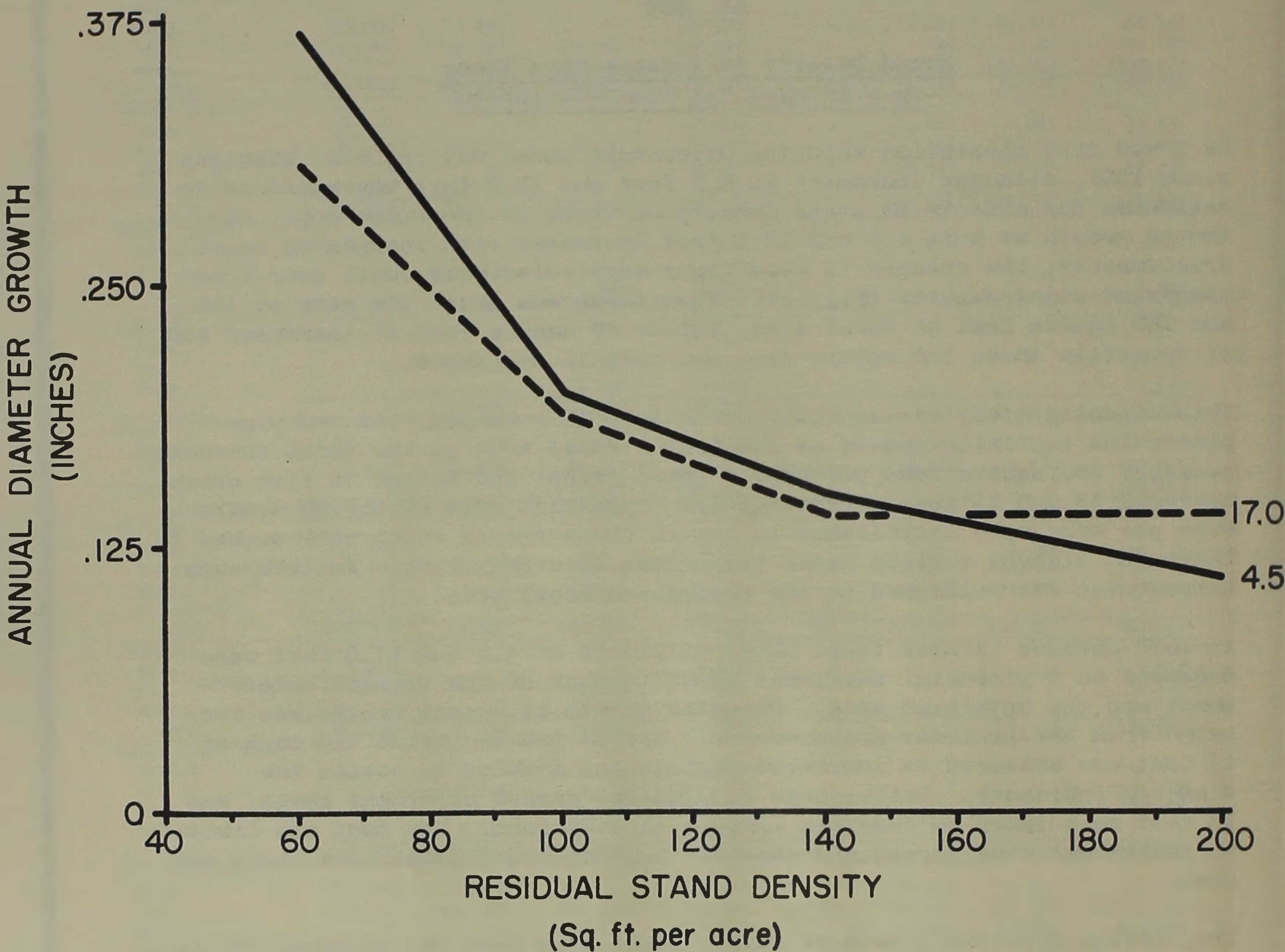

Figure 1.--Mean periodic annual diameter growth in a thinned red pine plantation, by basal area density; measurements are at 4.5 feet and 17 feet on the stem.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 608

Production of Miscellaneous Timber Products--Lake States, 1960[1/]

Changes in technology and consumer tastes have significantly affected production of miscellaneous timber products in the Lake States. Reported here are the findings of the latest biennial survey of these products cut in 1960 in each of the three Lake States. All known operators in Minnesota, Wisconsin, and Michigan were contacted.

Cooperage logs.--More than 10 million board feet of cooperage logs were cut--twice the quantity produced in 1958. Several southern manufacturers moving into the region accounted for part of the increase. Less importation of staves from other States was a factor also. Production was primarily for the whiskey barrel market, with some rough staves being exported to Scotland. (See table on back.)

Piling.--Piling production declined to 437,000 lineal feet, 29 percent less than the 1958 total. Increased competition from structural steel and a slowdown of the highway building programs have contributed to the decrease. Hardwood piling production was concentrated in Michigan, softwood production in Minnesota.

Poles.--More than 286,000 poles were cut in 1960, an increase of 23 percent over 1958. Continued construction of pole-type farm and commercial buildings created a market for the expanded production. Building poles are generally shorter than utility poles. Tamarack is becoming a more widely used pole species. Pole production was concentrated in Minnesota.

Chemical and charcoal wood.--Outdoor cooking with charcoal has been mainly responsible for the expanded demand for charcoal wood. Since 1958 production has nearly doubled; it totaled 317,000 cords in 1960. More than three-fourths of the cut was low-grade logs and bolts, while the remainder came from sawmill slabs, veneer cores, and other mill residues. The increased volume of residues used was principally in Michigan.

Excelsior bolts.--An expanded cut of 10,000 cords over 1958 boosted total output to 63,000 cords--still 23,000 cords less than in 1956. Excelsior has found additional markets in filters for air coolers, mink bedding, chick box pads, and poultry nest pads. Backing for archery targets continued to be an important use.

Heading stock.--Additional container-veneer mill closures and reduced operating levels resulted in the cutting of only 4,000 cords, one-third the 1958 volume. Continued market inroads by competing products, such as plastic and cardboard containers, have severely limited activities in the container veneer industry.

1/ Includes all logs and bolts except lumber and veneer logs, mine timbers, match and lath bolts, and pulpwood.

JULY 1961

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(over)

Production of miscellaneous timber products, Lake States, 1960

Species	Minnesota	Wisconsin	Michigan	Total
		COOPERAGE LOGS (MBF Int'l 1/4" Rule)		
Basswood	575	4	-	579
Oak	2,488	7,268	-	9,756
Aspen	-	2	-	2
All species	3,063	7,274	-	10,337
		PILING (M lineal feet)		
Softwood	158	11	3	172
Hardwood	-	16	249	265
All species	158	27	252	437
		POLES (M pieces)		
Pine	97	24	-	121
Cedar	124	10	21	155
Tamarack	10	-	-	10
All species	231	34	21	286
		CHEMICAL AND CHARCOAL WOOD (M std. cords)		
Hardwood:				
Roundwood	3	58	183	244
Mill residue	2	24	47	73
All species	5	82	230	317
		EXCELSIOR BOLTS (M std. cords)		
Aspen	-	49	14	63
		HEADING STOCK (M std. cords)		
Aspen	*	2	*	2
Other hardwoods	*	2	-	2
All species	*	4	*	4

* Less than 500 cords.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 609

Veneer Log Production of Standard Grades up Slightly, Container Grades Down, Lake States, 1960

Timber operators harvested approximately 54 million board feet of veneer logs in the Lake States in 1960, according to a biennial survey recently completed by the Station (see table on reverse side). Although the 1960 cut was 3 percent larger than that of 1958, it was nearly 40 percent less than was cut 10 years ago.

Of the regional total, about 86 percent was cut for standard veneer plants while the remaining 14 percent was cut for plants producing container veneers for boxes, baskets, and crates. Wisconsin accounted for about 47 percent of the regional total, Michigan 34 percent, and Minnesota 19 percent. Michigan for many years was the region's leading veneer log producing state, but relinquished the number-one spot to Wisconsin several years ago. During the past 10 years Wisconsin and Minnesota have maintained annual cuts of around 25 million and 10 million board feet, respectively. Michigan's veneer log output, however, has dropped off sharply from about 50 million board feet to less than 20 million board feet annually.

More than half of the region's container veneer plants have gone out of business since 1950. Most of the defunct large container plants were located in Michigan. Loss of these mills has resulted in bringing about a sharp decline in Michigan's veneer log output in recent years.

Exports of walnut veneer logs from Wisconsin and Minnesota in 1960 showed substantial increases over those of other years. A large proportion was shipped via railroad to Montreal, Canada, then by boat to European countries.

Total 1960 veneer log receipts at Lake States mills were about 64½ million board feet, 12 percent more than in 1958. This increase was not general throughout the region: Wisconsin mills registered an increase of nearly 20 percent, while plants in both Michigan and Minnesota procured less logs than in 1958. Local operators supplied 80 percent of the veneer logs, Canada 11 percent, and other states 9 percent (see table below). 1960 imports from other states and Canada were much larger than in 1958.

Geographic origin and destination of veneer logs received by Lake States plants, 1960

Species	Percent of veneer logs originating from:					Percent of veneer logs received by:		
	Minn.	Wis.	Mich.	Other U. S.	Canada	Minn. mills	Wis. mills	Mich. mills
Aspen	27	64	9	-	-	-	99	1
Ash	21	55	12	12	-	3	92	5
Basswood	30	45	17	8	-	5	81	14
Beech	-	25	75	-	-	-	39	61
Birch	11	20	43	-	26	1	69	30
Cottonwood	39	18	1	42	-	9	90	1
Elm	24	42	17	17	-	2	80	18
Maple, hard	5	39	39	-	17	-	81	19
Maple, soft	16	42	21	21	-	1	83	16
Oak	14	70	3	12	1	-	94	6
Walnut	100	-	-	-	-	-	100	-
Misc. hardwoods	-	31	7	62	-	-	75	25
All species	15	38	27	9	11	2	79	19
Previous survey (1958)	15	40	34	2	9	3	75	22

July 1961

A. G. HORN
Research Forester

Production and imports of veneer logs, Lake States, 1960

(Thousand board feet International 1/4-inch log rule)

Species and destination	Production by states[1/]				Imports			Total receipts
	Minnesota	Wisconsin	Michigan	Region	Other U. S.[2/]	Canada	Total imports	
Aspen								
Minnesota	2	-	-	2	-	-	-	2
Wisconsin	566	1,336	172	2,074	-	-	-	2,074
Michigan	-	-	23	23	-	-	-	23
Total	568	1,336	195	2,099	-	-	-	2,099
Ash								
Minnesota	30	-	-	30	-	-	-	30
Wisconsin	203	600	102	905	101	1	102	1,007
Michigan	-	-	31	31	25	-	25	56
Total	233	600	133	966	126	1	127	1,093
Basswood								
Minnesota	334	-	-	334	-	-	-	334
Wisconsin	1,472	3,056	421	4,949	537	8	545	5,494
Michigan	200	-	724	924	-	-	-	924
Total	2,006	3,056	1,145	6,207	537	8	545	6,752
Beech								
Minnesota	-	-	-	-	-	-	-	-
Wisconsin	-	241	137	378	-	-	-	378
Michigan	-	-	583	583	-	-	-	583
Total	-	241	720	961	-	-	-	961
Birch								
Minnesota	255	-	-	255	-	-	-	255
Wisconsin	1,416	3,846	4,819	10,081	1	2,896	2,897	12,978
Michigan	300	-	3,367	3,667	-	2,052	2,052	5,719
Exported[3/]	-	30	42	72	-	-	-	-
Total	1,971	3,876	8,228	14,075	1	4,948	4,949	18,952
Cottonwood								
Minnesota	292	-	-	292	-	-	-	292
Wisconsin	986	603	-	1,589	1,369	-	1,369	2,958
Michigan	-	-	35	35	-	-	-	35
Total	1,278	603	35	1,916	1,369	-	1,369	3,285
Elm								
Minnesota	116	-	-	116	-	-	-	116
Wisconsin	1,371	2,564	36	3,971	1,013	-	1,013	4,984
Michigan	-	-	1,025	1,025	60	-	60	1,085
Total	1,487	2,564	1,061	5,112	1,073	-	1,073	6,185
Maple, hard								
Minnesota	1	-	-	1	-	-	-	1
Wisconsin	610	4,792	2,540	7,942	59	1,819	1,878	9,820
Michigan	-	-	2,165	2,165	-	200	200	2,365
Exported[3/]	-	100	723	823	-	-	-	-
Total	611	4,892	5,428	10,931	59	2,019	2,078	12,186
Maple, soft								
Minnesota	32	-	-	32	-	-	-	32
Wisconsin	555	1,509	181	2,245	764	8	772	3,017
Michigan	-	-	590	590	-	-	-	590
Total	587	1,509	771	2,867	764	8	772	3,639
Oak								
Minnesota	-	-	-	-	-	-	-	-
Wisconsin	1,186	5,437	240	6,863	1,001	69	1,070	7,933
Michigan	-	450	34	484	-	-	-	484
Exported[3/]	-	66	197	263	-	-	-	-
Total	1,186	5,953	471	7,610	1,001	69	1,070	8,417
Walnut								
Minnesota	-	-	-	-	-	-	-	-
Wisconsin	14	-	-	14	-	-	-	14
Michigan	-	-	-	-	-	-	-	-
Exported[3/]	63	410	155	628	-	-	-	-
Total	77	410	155	642	-	-	-	14
Misc. species								
Minnesota	-	-	-	-	-	-	-	-
Wisconsin	1	265	11	277	362	2	364	641
Michigan	-	-	51	51	160	-	160	211
Exported[3/]	88	162	83	333	-	-	-	-
Total	89	427	145	661	522	2	524	852
All species								
Minnesota	1,062	-	-	1,062	-	-	-	1,062
Wisconsin	8,380	24,249	8,659	41,288	5,207	4,803	10,010	51,298
Michigan	500	450	8,628	9,578	245	2,252	2,497	12,075
Exported[3/]	151	768	1,200	2,119	-	-	-	-
Total	10,093	25,467	18,487	54,047	5,452	7,055	12,507	64,435

1/ Vertical columns of figures under box heading "Production by states" represents the quantity of veneer logs cut in each state.

2/ Central and eastern states.

3/ Veneer logs shipped to mills outside Lake States region.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 610

Attraction of Wood-Boring Insects to Freshly Cut Pulpsticks

Wood-boring insects, which are highly destructive to pulpwood and sawlogs, damage the wood cylinder by excavating surface galleries and deep tunnels under the bark. Up to 5 percent of the volume in each conifer pulpstick may be lost; and lumber cut from infested logs may be degraded considerably.

A small study was conducted in 1961 in northern Minnesota to observe the rapidity of attraction of wood borer adults to freshly cut conifers. Five balsam fir trees were felled, cut into short pulpsticks, and arranged in four piles around the slash heap in a clearing. One large black spruce tree was also cut and stacked into a single pile near one of the balsam fir piles. The total volume of rough pulpwood was 57.8 cubic feet for the balsam fir and 13.5 cubic feet for the black spruce. Cutting began about 8:15 a.m. and was completed by 10:00 a.m. on August 4. All wood borers observed on the piles and slash were collected and recorded several times per day for the next 2 weeks. Collected insects were not released.

The first insect, the white-spotted sawyer (*Monochamus scutellatus*), was collected at 11:15 a.m., just 2 hours after cutting. The numbers of *Monochamus* and other insects mounted steadily after that, and by nightfall 255 adults of several genera of wood borers had been collected. Of these, 229 were *M. scutellatus* and 13 were a closely related species, *M. marmorator*. The remaining insects and the numbers collected were: *Xylotrechus undulatus* (4), *Anoplodera canadensis* (1), *Buprestis maculiventris* (1), *Chrysobothris scabripennis* (1), *Urocerus albicornis* (3), *Urocerus flavicornis* (2), and *Sirex cyaneus* (1). During the remaining period of the study *Monochamus notatus*, *Serropalpus substriatus*, and *Pissodes dubius* were also collected.

Previous studies in this area have shown that, of the various insects attacking balsam fir and black spruce, species of *Monochamus*, especially *M. scutellatus*, are the most destructive. Other genera are unimportant at present, principally because of their low populations. *M. scutellatus* was the most abundant insect attracted to the piles during this study (table 1), and over one-half (229) of the total (436) was collected the first day. *M. marmorator* was also important, but only 32 were collected over the 2-week period. The number of *Monochamus* beetles dropped considerably the second day (fig. 1); thereafter it increased daily until a second influx on August 8 produced one-third as many as on the first day. Numbers declined steadily after that until the end of the test.

Mating, egg-niche cutting, and egg laying were all observed on the first day of the test. Each female is known to cut several egg niches in the bark and to deposit one or more eggs in these slits. The speed with which large populations of *Monochamus* beetles collected, plus the fact that 55 percent were females, points out the necessity for fast and efficient protection of rough pulpwood and sawlogs cut in the summer and left in the field after cutting. If each female laid only one egg the first day, within 2 weeks over 120 larvae would develop from that attack alone, and subsequent egg laying would increase the number greatly.

Since the white-spotted sawyer needs from 12 to 23 months to complete its life cycle, depending on the location, a few months to over a year are needed before the larvae can cause appreciable damage. If the logs are to be utilized within a few months, wood loss will usually be negligible. Otherwise, rough logs should be removed from the cutting site immediately or, since this is generally impractical, other methods of protection should be employed. Spraying the piles or logs immediately after cutting with insecticides such as benzene hexachloride (BHC), covering them with a heavy layer of slash, or piling them in the shade of standing trees will protect them substantially.

October 1961

LOUIS F. WILSON, Forest Entomologist

Table 1.-- Wood-boring insects obtained from pulpwood over a 2-week period in northern Minnesota

Species	Number
Order Coleoptera	
Family Cerambycidae	
Monochamus scutellatus (Say)	436
Monochamus marmorator Kirby	32
Monochamus notatus (Drury)	3
Xylotrechus undulatus (Say)	18
Anoplodera canadensis (Oliv.)	1
Family Buprestidae	
Buprestis maculiventris Say	1
Chrysobothris scabripennis L.&G.	4
Family Melandryidae	
Serropalpus substriatus (Halman)	17
Family Curculionidae	
Pissodes dubius Rand.	5
Order Hymenoptera	
Family Siricidae	
Urocerus albicornis (F.)	7
Urocerus flavicornis (F.)	8
Sirex cyaneus F.	6
Total	538

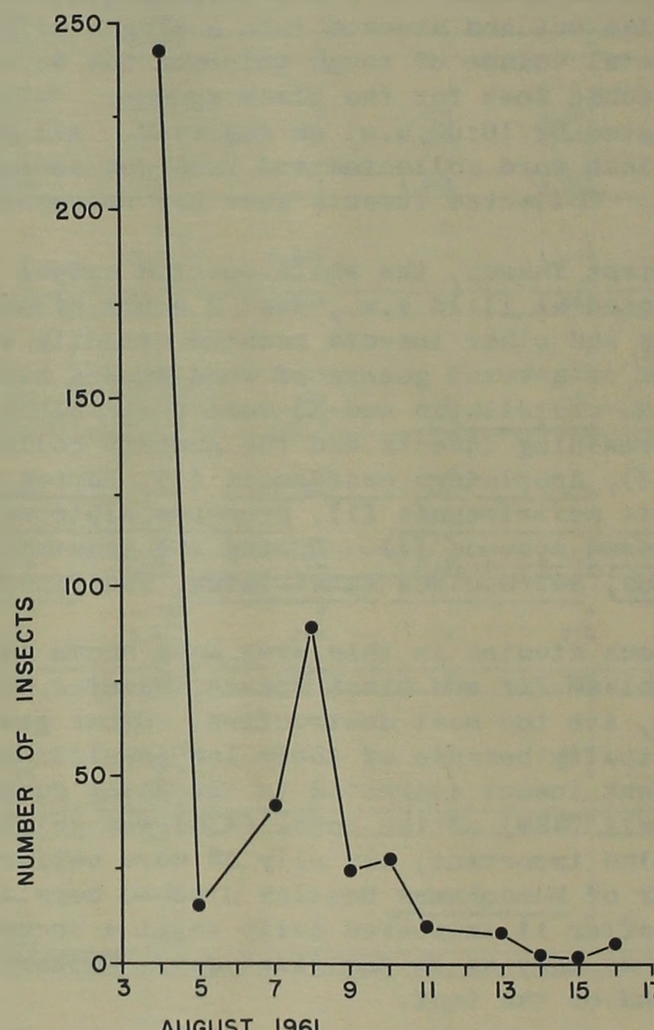

Figure 1.--Daily collections of *Monochamus* species on the pulp piles.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 611

Investment Opportunities in Regenerating Black Spruce Are Greatly Affected by Site

Site quality is an important factor to be considered when regenerating stands of black spruce. It may determine how a stand is to be regenerated, and thus affect regeneration costs. On poor sites natural regeneration often can be obtained at little cost, whereas on good sites expensive site preparation and planting may be required. An investment made now in establishing a stand, whether by planting or by obtaining natural regeneration, is expected to yield future returns. The amount and timing of these returns vary considerably with site. The economic analysis presented here shows that site greatly affects the margin that can be invested profitably in regenerating black spruce stands.

The values of expected returns at various ages from a fully stocked stand of black spruce were obtained by applying a stumpage price of $6 per cord to the cordwood volumes in the normal yield tables given by LeBarron.[1/] Experience with these tables indicates that they provide a good estimate of actual yields from well-stocked, relatively even-aged stands of black spruce. From these value yields for good, medium, and poor sites (site index 39, 33, and 26 at age 50, respectively), the margins available for profitable investment in stand establishment at the beginning of each rotation were computed for discount rates of 2, 3, 4, and 6 percent for a range of land values, using a soil expectation value formula. Constant annual management expenses of $0.30 per acre were assumed. The margin available for stand establishment is the maximum amount per acre that could be invested in establishing a well stocked black spruce stand on land of a given value and still provide at least the stated rate of return from managing the stand. The results of this analysis are summarized in figure 1.

The most striking fact brought out is the difference between sites in the amount that can be profitably invested in regeneration. On poor sites, even the smallest investment in stand establishment is not profitable at discount rates above 2 percent. With a land value of $3 per acre and a discount rate as low as 2 percent, an investment of more than $5 per acre in regenerating poor sites would not be profitable. In contrast, at the same 2-percent discount rate but with a higher land value of $10 per acre, more than $40 per acre could be profitably invested in regenerating good-site black spruce stands.

As figure 1 shows, the forest landowner can profitably invest much more in establishing stands on good sites than on poor sites, even if good sites have a considerably higher value. At a discount rate of 2 percent, he can invest

1/ LeBarron, Russell K. Silvicultural management of black spruce in Minnesota. U.S. Dept. Agr. Cir. No. 791. 60 pp., illus. 1948. (p. 30., trees over 3.5 inches d.b.h.).

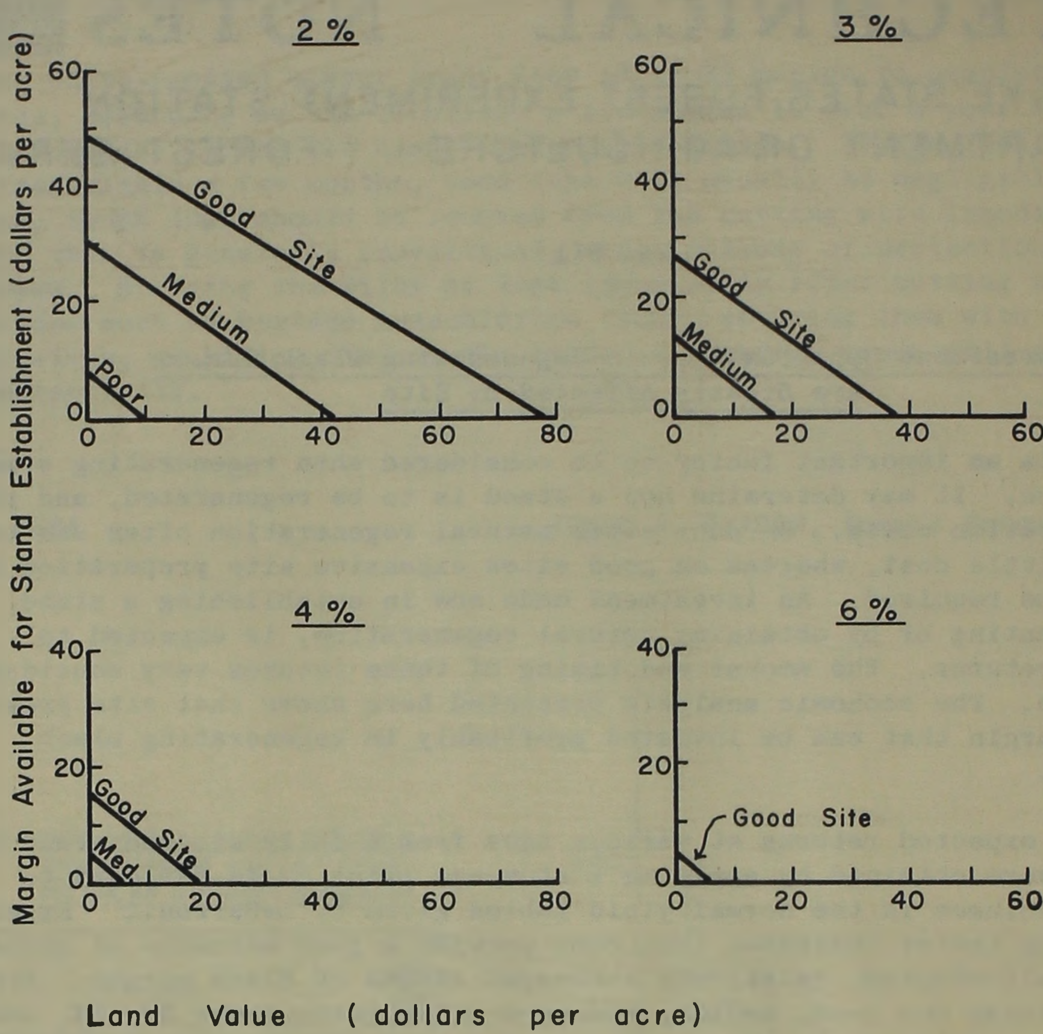

Figure 1.--Margin available for establishing a stand of black spruce for a range of land values on three site classes (good, site index 39 at 50 years; medium, site index 33; poor, site index 26) and at four discount rates. Stumpage price, $6 per cord; annual management expenses, $0.30 per acre.

$20 per acre more on medium sites and almost $40 per acre more on good sites than he can on poor sites, given the same land value for all sites. How much more he can invest on the better sites will depend upon the discount rate he uses, the land value, and his stumpage price and cost expectations. A similar analysis could be made for other stumpage prices and management costs.

In evaluating stand establishment practices from an investment viewpoint, not only the total cost of stand establishment but also the expected returns must be considered. This analysis demonstrates the importance of site and land value on regeneration investment decisions and points out the need for determining site as a measure of the land's productivity before making such decisions.

October 1961

Allen L. Lundgren
Research Forester (Economics)

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 612

The Forest-Land Gully in the Driftless Area-- Natural or Man-Caused?[1]

In the Driftless Area of southwestern Wisconsin, southeastern Minnesota, and northeastern Iowa, forest-land gullies are an all-too-common blight on the landscape (fig. 1). They can be seen at almost any turn of the road on the steep, wooded slopes of this unglaciated region. Where they break out of the woods onto cleared land at the foot of the slope they often terminate in alluvial deposits of rocks and boulders. Locally these are known as rock or limestone runs. They are a frequent cause of major damages to agricultural land and to roads, bridges, and stream systems following heavy rains.

To understand the problem one must first be able to picture the land. It is a dissected peneplain made up of flat-topped ridges, steeply sloping hillsides, and narrow valley floors. Ridgetops as well as lower slopes and bottom lands are farmed. Forests normally occupy only the steeper land in between.

This unique land-use pattern suggests that the forest-land gully could be caused by runoff from upland fields. Extensive travel and observation in the area lend support to this idea. Walk up any forest-land gully and you will find a field. A 1936 forest survey report states: ". . . in 80 square miles that we have covered to date on this survey we have not found a single instance of erosion through forest except where it has been caused by open fields on the ridgetop."[2]

Natural or man-caused? In seeking further evidence it was reasoned that if the gullies were caused only by runoff from fields, then forested slopes that did not lie below fields should have no gullies. Most ridgetops were cleared for farming long ago, but here and there one was considered too narrow to be farmed, so it was left in timber. By examining air photos we located a number of such timbered ridges in the La Crosse, Wis., area.

Forty completely forested watersheds were spotted on the air photos, and then examined on the ground to check for gullies or other signs of surface flow. Not a single gully or eroded channel was found. Where a natural channel did exist it invariably faded away at the base of the slope, disappearing under the ancient alluvium of the valley floor. It often ended in a cultivated field, and there was no indication that water from the wooded slopes had ever discharged onto the field (fig. 2).

Further support to the man-caused theory is given by an early experiment near La Crosse which showed that forest land yielded little overland flow, even under severe runoff conditions.[3]

Although neither our recent study nor the earlier ones cited positively prove that gully erosion was not a feature of the natural landscape, the combined evidence strongly supports this conclusion.

October 1961 | Richard S. Sartz, Research Forester

1/ The Station's research in the Driftless Area is conducted by the La Crosse, Wis., field unit in cooperation with the Wisconsin Conservation Department.

2/ Lake States Forest Experiment Station. Unpublished report. 1936.

3/ Hays, O. E., Mc Call, A. G., and Bell, F. G. Investigations in erosion control and the reclamation of eroded land at the Upper Mississippi Valley Soil Conservation Experiment Station near La Crosse, Wis., 1933-43. U.S. Dept. Agr. Tech. Bul 973, 87 pp., illus. 1949.

Figure 1.--Gully through forested slope of the Driftless Area.

Figure 2.--Outlet of 53-acre wooded watershed blends into alluvial fill of the valley. An artificial channel had to be dug to install a runoff measuring instrument on this watershed.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 613

An Inexpensive Water-Level Point Gage[1/]

Point gages are often needed at water-level recording stations to provide checks on the performance of the recorder. Commercial gages are available for this purpose. But since they are quite expensive, most establishments using this equipment have only one, which is moved from one water-level measuring station to another. So that a point gage could be permanently mounted at each gaging site, an inexpensive point gage was designed (fig. 1).

Materials needed for the gage are:

1 piece aluminum, 1/4" x 1" x 34"

4 flat head bolts, 1/2", No. 10-24

1 flat head bolt, 1", No. 10-32

1 thumb nut to fit No. 10-32 bolt (knurled nut shipped with each recorder for securing chart cylinder to the stud)

1 rubber washer to fit No. 10-32 bolt

Cost of materials is approximately one dollar. Construction is relatively simple; instructions and photographs are given on the back of this page. The unit can be fabricated and assembled in about 2 hours by local craftsmen.

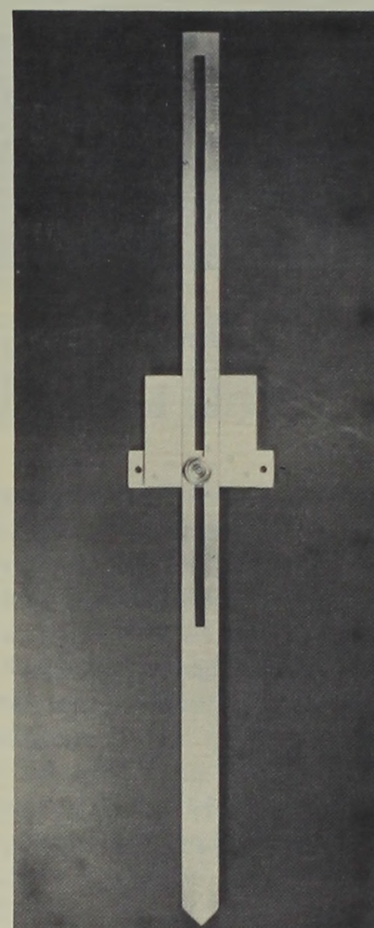

Figure 1.--Point gage complete.

October 1961

WILLIE R. CURTIS, Research Forester

1/ Reported from the Station's La Crosse, Wis., field unit, where research is conducted in cooperation with the Wisconsin Conservation Department.

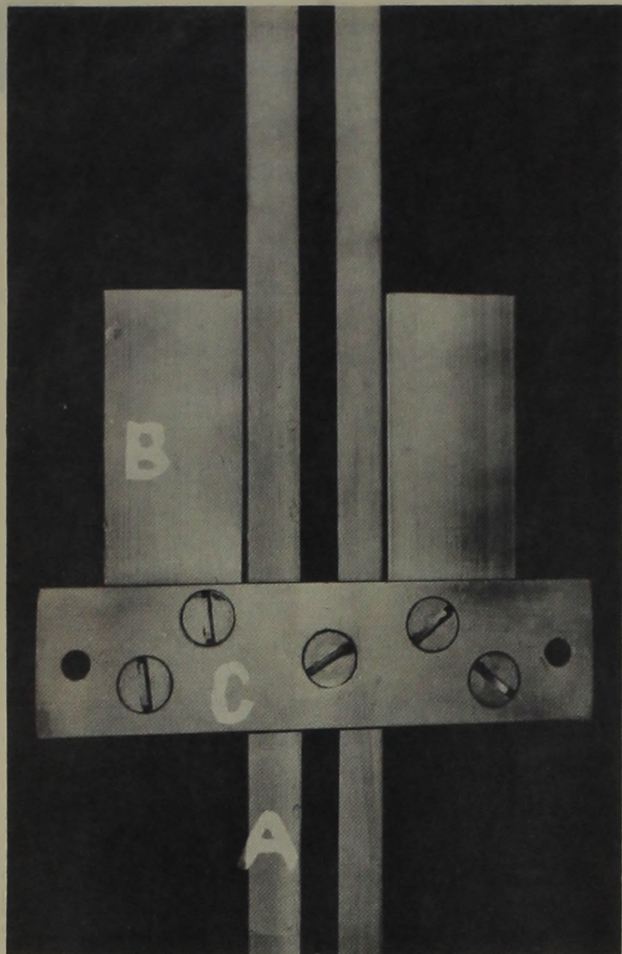

Figure 2.--Construction detail of mounting bracket. Holes near sides are for mounting to reference bar.

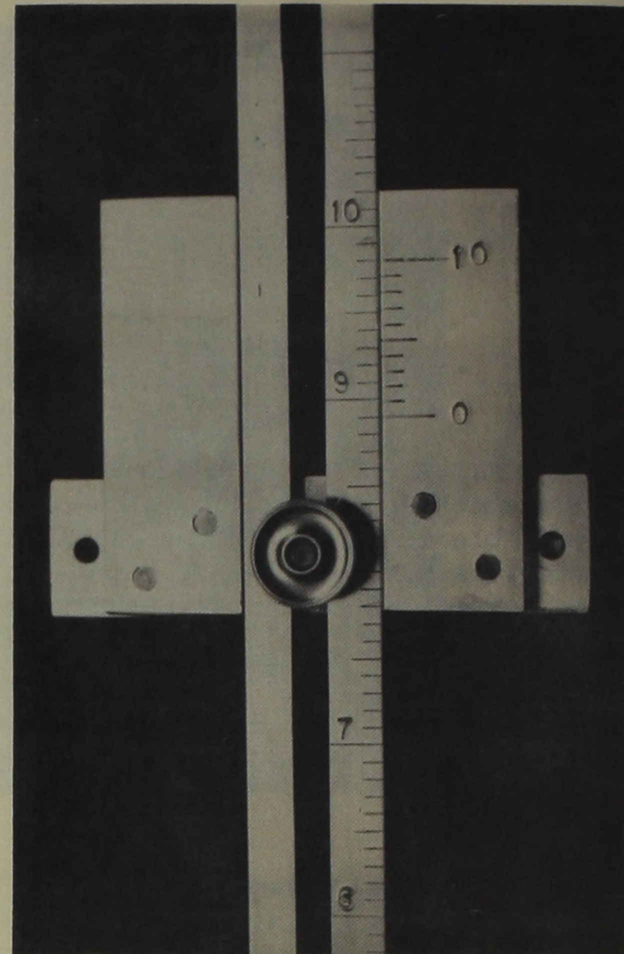

Figure 3.--Detailed front view of gage showing graduation of staff and vernier and thumb nut.

The 34-inch piece of aluminum is cut into four lengths: one 24-inch, one 4-inch, and two 3-inch sections (fig. 2, parts A, C, and B respectively). A 1/4-inch-wide slot is cut in part A for a distance of 15 inches, beginning about an inch from one end. The lower end is beveled to a wedge point of approximately 90°.

The 4-inch piece (part C) used as the mounting bracket has two holes for attaching to a reference bar. Parts B are attached 1 inch apart with two screws each, the heads of which are countersunk in C. The center screw, mounted in a tapped hole in C, serves as a holder for the thumb nut used for securing A (fig. 3). The right-hand side of A is graduated in feet, tenths, and hundredths, and a vernier, made by graduating 0.09 of a foot into 10 equal parts, is etched on part B to complete the construction.

To take a reading, the thumb nut is loosened and the staff is lowered to a point just above the water surface. The nut is then tightened so that the staff can be moved under slight pressure. A rubber washer between the nut and staff permits this.

The gage described here was designed to measure a range in head of 1 foot. It can be mounted on a reference bar 20 inches above the zero water level. For longer gages it might be desirable to attach a section comparable to C across the tops of parts B. This would give more bearing surface and reduce the chances of tilting the gage forward or backward during reading.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 614

DOWNWARD TREND OF WOODLAND GRAZING IN SOUTHERN MICHIGAN

The southernmost 37 counties of Michigan account for an important segment of the state's timber product output. For instance, in recent years this area has produced about 20 percent of the value of all rough products cut from Michigan's forest land--despite the fact that the southern Michigan forests represent only 13 percent of the state's commercial forest area. Notwithstanding their contribution, these forests are not producing at full capacity.

One factor which has tended to reduce the productivity of southern Michigan's forest resource is grazing by livestock. Not only does grazing hinder stand regeneration, it leads to quality losses in mature timber. As late as 1945, one-third of the forest land in southern Michigan was being used for pasture. Since that time, however, the acreage of grazed woodlots has steadily decreased (fig. 1) to where, in 1960, less than one-fifth of southern Michigan's 2.6 million acres of forest land was pastured. This represents a reduction of 43 percent.

The decrease in acreage of grazed woodland since World War II has not resulted from a decrease in total farm woodland. The latter acreage figure has remained virtually static during this period.[1/] Rather, the reduction in pastured forest land reflects the fact that many southern Michigan farmers have shifted from the production of dairy products to other agricultural commodities. Figure 1 depicts the close correlation between the number of milk cows being maintained and the acreage of grazed woodland in southern Michigan.

With the proximity to expanding population centers, it may seem strange that southern Michigan farms are producing less dairy products. One probable reason for this paradoxical situation is that high factory wages have attracted potential farm laborers to the cities. Another is that more farmers are working part-time off the farm. These two

1/ Since total agricultural land in southern Michigan has decreased 6 percent since 1945, one would expect the acreage of farm woodland to drop at least as much. One plausible reason for this not being the case stems from the fact that the acreage of "farm woodland" has always been determined from direct questioning of the farmer. Portions of farms now identified by the owners as woodland may not have been so classed in 1945.

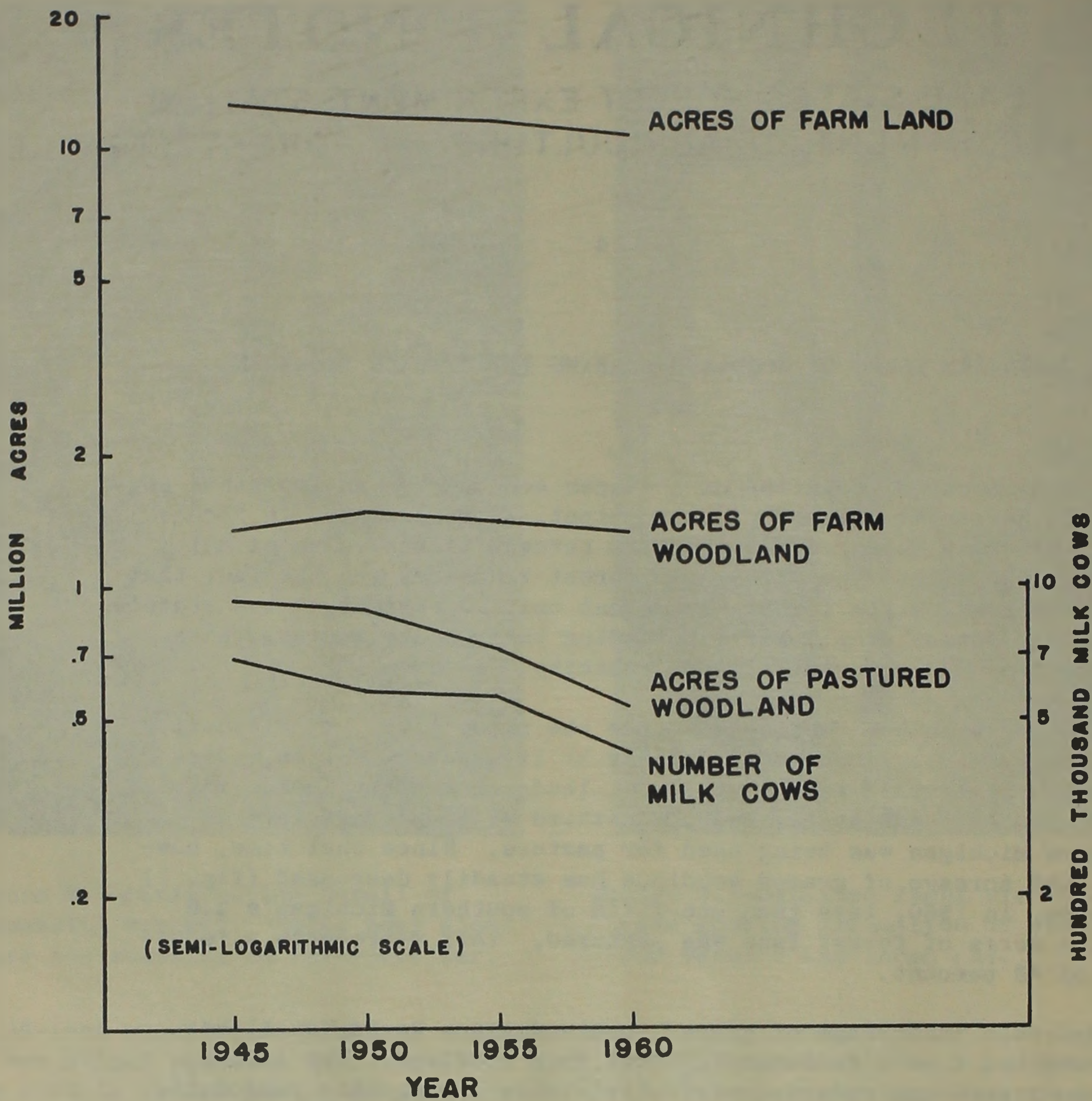

Figure 1.--Changes in dairy herd size in relation to agricultural land use patterns in southern Michigan. (Source: Census of Agriculture)

factors may have caused southern Michigan farmers to reduce the number of those kinds of livestock requiring considerable labor inputs.[2/] Though the forest area grazed may cease to diminish in the future, the reduction during the last 15 years should help improve timber-growing conditions in southern Michigan's woodlands.

2/ Cf., Wright, Karl T. Changes in food-grain production and livestock numbers in Michigan, Mich. Agr. Expt. Sta. Special Bul. 407, 1956, p. 30.

October 1961

Con H Schallau
Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 615

1961 Forest Tree Seed Crop Averages Poor in the Lake States

The 1961 forest tree seed crop was, generally, the poorest since 1949, according to observations made at field centers of the Lake States Forest Experiment Station. One or more species had crop failures in each locality of the region and bumper crops were rare (see table on reverse side). Production was better in North Dakota and northern Minnesota than it was further east in the region. Compared to 1960, production was poorer everywhere except in North Dakota.

In northern Minnesota the two aspen species and balsam poplar had bumper crops in some localities, and the oaks and sugar maple had good crops. Failures were reported in some localities for white pine, the spruces, balsam fir, tamarack, and the birches. Most other reports ranged from poor to fair.

In northeastern Wisconsin, seed crop failures were reported for all conifers, the birches, and black ash. Red maple, American elm, and northern red oak had fair crops, and all other species, poor ones.

Reports indicated crop failures for the spruces, hemlock, sugar maple, yellow birch, and black ash in central Upper Michigan. American elm and red oak had good crops. All other species had poor to fair crops.

In Lower Michigan jack pine, the two aspens, and black cherry had fair seed crops. Poor crops or failures were reported for all other species.

In north-central North Dakota observers report good seed crops for boxelder, green ash, chokecherry, and caragana. The hackberry crop failed again this year, and all other species in this area had poor to fair crops.

Most seed collectors are interested primarily in the pines and spruces, so 1961 will be rated a poor seed year. Mast production for some wildlife species, however, was fairly good, except in Lower Michigan.

January 1962

PAUL O. RUDOLF, Research Forester

Table 1.--Forest tree seed crops in the Lake States, 1961

Species	Estimated percentage of a full crop[1/] in--				
	Northern Minnesota	Northeastern Wisconsin	Central Upper Michigan	Lower Peninsula Michigan	North-central North Dakota
Red pine	25-75	7	50	25	[2/] -
Eastern white pine	7-25	7	25	7	-
Jack pine	25-50	7	-	50	-
Ponderosa pine	-	-	-	-	7
White spruce	7-25	7	7	7	-
Black spruce	7-25	7	7	7	-
Balsam fir	7-50	7	50	7	-
Eastern hemlock	-	7	7	25	-
Northern white-cedar	25-50	-	50	7	-
Tamarack	7-50	-	-	7	-
Sugar maple	75	25	7	7	-
Red maple	-	50	75	25	-
Boxelder	-	-	-	-	75
American beech	-	-	25	7	-
Basswood	50	25	25	7	-
Yellow birch	7-25	7	7	-	-
Paper birch	7-50	7	-	7	-
Quaking aspen	75-95	-	-	50	-
Bigtooth aspen	95	-	-	50	-
Balsam poplar	95	-	-	-	-
American elm	-	50	75	25	25
Siberian elm	-	-	-	-	25
Hackberry	-	-	-	-	7
White ash	-	25	-	25	-
Green ash	-	-	-	-	75
Black ash	25-75	7	7	-	-
Bur oak	75	-	-	-	50
Northern pin oak	75	-	-	7	-
Black oak	-	-	-	7	-
Northern red oak	75	50	75	7	-
White oak	-	-	-	7	-
Black cherry	-	-	-	50	-
Chokecherry	-	-	-	-	75
American plum	-	-	-	-	50
Russian-olive	-	-	-	-	50
Caragana	-	-	-	-	75

1/ Percentage of a full crop classified as 0-15, failure; 16-35, poor; 36-60, fair; 61-90, good; and 91-100, bumper.

2/ A dash (-) signifies no report on this species.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 616

Red Pine Plantation With 48 Sources of Seed Shows Little Variation in Total Height at 27 Years of Age

In 1937 red pine seedlings from 48 individual seed sources in the Lake States (including one from nearby Angus, Ontario, Canada) were planted in a 1.4-acre plantation on the Pike Bay Experimental Forest near Cass Lake, Minn. The trees, 2-1 transplants, came from seed left over from the supply used for the original seed source plantations of 1931 and 1933. These had been inadvertently destroyed.

The plantation was thinned in 1951, 1956, and 1961 to give adequate growing room to all seed sources. In general, trees poorer in form and smaller than average were removed in thinning. The 48 seed sources were spaced throughout the plantation in 92 rows. Each seed source appeared in one or more rows; each source row contained at least four trees of the source; each source row was treated as a separate observation. There was no evidence of a site gradient in the plantation.

Twenty-four years after planting, or 27 years from seed, the height of each tree of a given source was measured and the average height calculated. The results are given in table 1. The seed sources are arranged by regional groupings as proposed by Rudolf[1/] for the Camp 8 source-of-seed plantation near Ely, Minn.

There was no significant difference in average tree height between the eight regional groupings. The mean height for all seed sources is 39.8 feet; the regional averages depart from this mean by no more than 0.7 feet.

There was no significant difference in average tree heights within regional groupings except for the head-of-the-lakes and the Lower Michigan sources. In the head-of-the-lakes region, the Ashland, Wis., seed source is suspected of being inferior. This seed source is 2.5 feet shorter than the regional mean of 39.3 feet. In the Lower Michigan seed sources there is apparently more variability in average tree heights than in other regions. No one source is better than the best from other regions, nor is the poorest (Bay City, Mich.) poorer than the worst from other regions.

This study, up to this date at least, suggests that red pine exhibits less racial variation in height growth than do most pines. With one possible inferior source (Ashland, Wis.), none of the seed sources appear to have markedly better or worse height growth than other seed sources.

From the silvicultural standpoint, the most striking feature of this plantation is its per-acre growth rate. Counting thinnings and present standing volume, the plantation has produced 36.5 cords of wood per acre in 27 years from seed.[2/]

1/ Rudolf, Paul O. Importance of red pine seed source. Soc. Amer. Foresters Proc. (1947 meeting): 384-398. 1947.

2/ See the following reference for utilization standards and growth rates up to 22 years from seed: Zasada, Zigmond A., and Buckman, Robert E. Growth and yield of a young plantation in northern Minnesota. U. S. Forest Serv. Lake States Forest Expt. Sta. Tech. Note 491, 2pp. 1957.

Robert E. Buckman, Research Forester
Roland G. Buchman, Mathematical Statistician

January, 1962

Table 1.--Average height of red pine from 48 seed sources in the Lake States 24 years after planting

Collection no.	Origin	Number rows planted	Avg. height (feet)
	NORTHWESTERN MINNESOTA		
76	Ponsford	2	39.1
143	Cass Lake	1	41.2
144	Cass Lake	2	39.7
146	Hibbing	2	39.4
176	Menahga	2	41.0
178	Itasca Park	4	41.4
179	Itasca Park	3	39.2
180	Bemidji-Wilton	2	38.2
181	Bagley	1	39.7
188	Cass Lake	3	39.5
324	Itasca Park	4	40.1
	Regional average		39.9
	BRAINERD, MINNESOTA-CAMERON, WISCONSIN		
75	Onamia, Minn.	5	40.0
148	Moose Lake, Minn.	2	39.9
158	Taylors Falls, Minn.	2	39.5
160	Cameron, Wis.	2	40.6
161	Cameron, Wis.	2	40.3
162	Cameron, Wis.	2	38.4
172	Brainerd, Minn.	1	41.8
174a	Brainerd, Minn.	1	40.6
	Regional average		40.1
	NORTHEASTERN MINNESOTA		
35	Ely	2	38.3
36	Aurora	2	41.1
37	Virginia	2	39.5
183	Warroad	2	39.8
	Regional average		39.7
	UPPER PENINSULA, MICHIGAN		
237	Bruce Crossing	2	39.5
240	Baraga	1	39.9
	Regional average		39.7
	HEAD-OF-THE-LAKES		
24	Barnes, Wis.	2	39.7
48	Ashland, Wis.	2	36.8
141	Scanlon-Carlton, Minn.	2	40.9
165	Cedar, Wis.(Iron Co.)	2	38.3
167	Red Cliff, Wis.	1	38.8
168	Portwing, Wis.	1	39.9
170	Solon Springs, Wis.	1	39.4
300	Bayfield, Wis.	2	40.9
	Regional average		39.3
	NORTHEASTERN WIS.-SOUTHERN UPPER PENINSULA		
10	Trout Lake, Wis.	2	39.9
19	Iron Mountain, Mich.	1	40.0
220	Brussels, Wis.	2	41.1
295	Wis.-Upper Peninsula (commercial seed)	4	39.5
298	Trout Lake, Wis.	1	42.0
	Regional average		40.5
	CENTRAL WISCONSIN		
60	Kilbourn	1	37.1
61	Tomah	1	39.8
64	Menominee	1	39.8
104	Holmen	1	38.2
108	Black River Falls	2	40.1
108a	Black River Falls	2	39.8
	Regional average		39.1
	LOWER MICHIGAN AND ADJACENT ONTARIO, CANADA		
30	Houghton Lake, Mich.	2	40.3
81	Huron N. F., Mich.	2	41.8
117	Angus, Ontario, Canada	2	39.7
189	Bay City, Mich.	1	37.6
	Regional average		39.9
	Average all regions		39.8

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 617

Sprouting of Northern Oaks Reduced After Debarking With Sodium Arsenite

Sodium arsenite applied to cut-bark treatments usually gives excellent topkill in northern oaks and is an effective bark-loosening agent (Technical Note 445) in the utilization of these species for pulpwood. A followup study of the effect on sprouting 6 growing seasons after treatment showed a significant reduction in the percentage of stumps sprouting and the number of sprouts per stump (fig. 1).

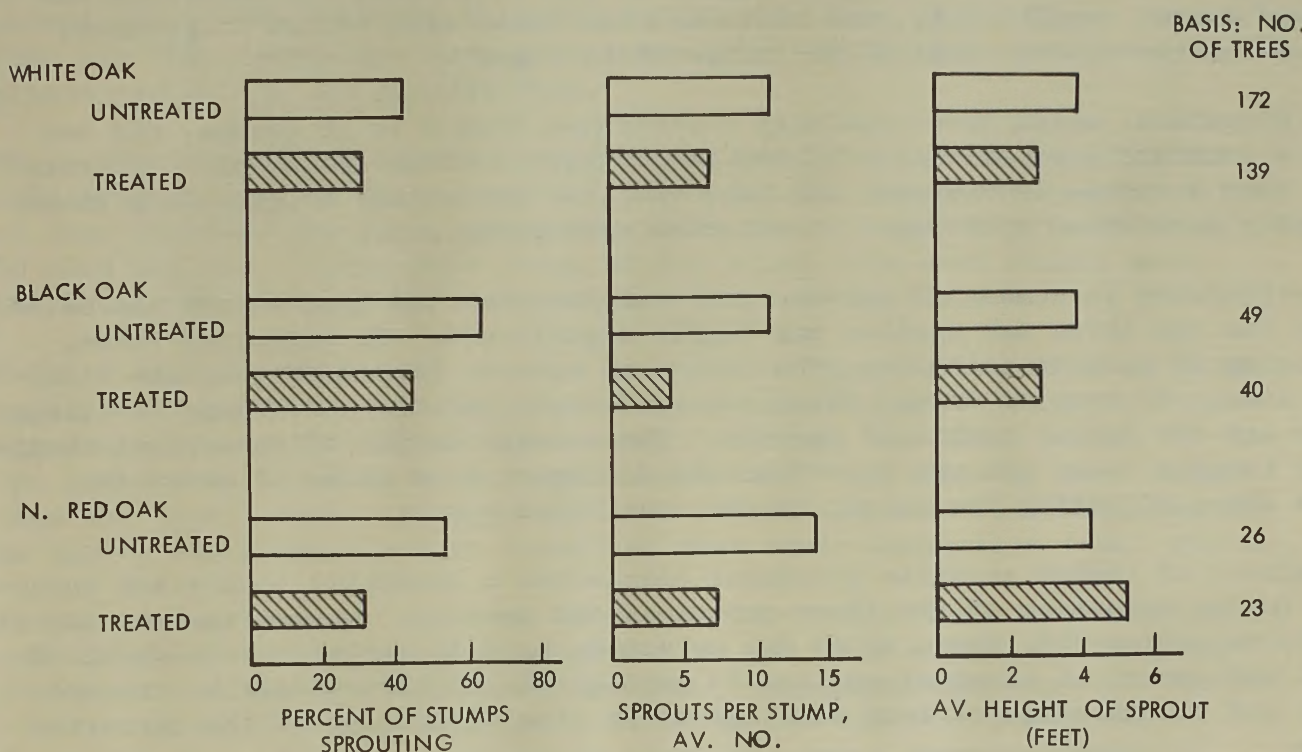

Figure 1.--Sprouting characteristics of northern oak species 5 years after debarking with sodium arsenite.

The tests were established in a northern oak stand growing on Grayling sand in the Pine River Experimental Forest, Wexford County, Mich. In early June 1955 all trees 5.0 inches d.b.h. and larger on four 2½-acre compartments were treated with a 40-percent solution of sodium arsenite. The chemical was applied at stump height with a 4-inch brush in a barked zone between two frill girdles. The barked zone was as wide as the tree d.b.h. These trees and 10 acres of untreated trees were felled the following spring and early summer. The volume yield averaged 1,000 board feet and 10 cords of pulpwood per acre.

Species composition of the stand included: white oak, 57 percent; northern red oak, 24 percent; and black oak, including a small amount of northern pin oak, 16 percent of the merchantable stand basal area. Red maple and bigtooth aspen made up the remaining 3 percent of the basal area. Stand age ranged from 58 to 70 years and total height from 50 to 70 feet. Merchantable trees, those 5.0 inches and larger, averaged 136 per acre with 54 square feet of basal area. Smaller trees averaged 275 per acre with 11 square feet of basal area.

The sodium arsenite treatment resulted in a reduction from the expected number of trees sprouting for each species; the reduction was significant at the 1-percent level. This effect of treatment had occurred by the end of the first full growing season--approximately the same percentage of stumps were sprouting then as at the end of 6 growing seasons after treatment.

The greatest reduction in percentage of trees sprouting was in red oak (23 percent), and the smallest in white oak (12 percent). Black oak had the highest percentage of stumps sprouting, averaging 65 and 45 percent for untreated and treated trees, respectively, and white oak the least with 44 and 32 percent, indicating the species difference in sprouting vigor.

Tree diameters, which were regularly distributed from 5 to 15 inches, did not show a consistent relationship to the percentage of trees sprouting. If trees less than 5 inches in diameter had been cut, the percentage of sprouting would probably have shown a stronger correlation with stump size.

The difference in number of sprouts per stump between the treated and untreated trees for the three oak species was highly significant. On untreated trees, averaging 13 sprouts per stump, the number of sprouts tended to increase with tree size. On treated trees, which averaged eight sprouts per stump, the larger sizes had the fewest number of sprouts. The average height of sprouts on chemically treated trees was not significantly different from those of untreated trees after adjusting the height to the same total age.

The effect of sodium arsenite treatment thus shows a generally consistent reduction in the sprouting of the three principal oak species. Within species considerable variation did occur, which may be due in part to variations in depth of frill and amount of chemical applied in each girdle on the chemically treated trees and to the stage of leaf development at time of cutting on the untreated trees.

Where conversion of the northern oak type to coniferous plantations is planned, this treatment would give some reduction in sprouting during the critical establishment period. Although release work may be needed, since one-third of the stumps are now sprouting, it could be delayed until the diameter and height growth of the conifers would show a greater response and minimize the need for additional release.

January 1962

R. M. GODMAN, Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 618

White-Pine Weevil Damage Differs Significantly by Seed Source on Two Northern Minnesota Jack Pine Plantations

During 1958 and 1959 several nonlocal sources of jack pine in one of the regional seed source study plantations showed significantly higher damage from white-pine weevil than the local source.1/ The plantation concerned was on the Chippewa National Forest near Cass Lake, Minn. During 1960 and 1961 comparable data were taken from the Superior National Forest plantation on the old Wanless Farm.

These plantations are but two of 17 established before the onset of the 1954 growing seasons in the three Lake States.2/ The plantations consist of four replications of a randomized block design, each replication with 30 seed sources. Sixty-four trees of 2-0 stock from each source were set out in 40-foot square blocks with a 5x5-foot spacing.

Table 1 shows a comparison between sources for mean number of trees weeviled per acre per year on each of the two plantations. In neither did any source have significantly less weeviling than the local stock. On the Superior plantation no Michigan source had significantly more damage than the local stock. Both plantations showed the same Wisconsin sources as having significantly more weeviling than their respective local sources.

Of particular interest are some of the Minnesota sources. Two Cass County and the Becker County sources responded in the same manner as the local source in the nearby Chippewa Plantation. These same sources were weeviled more heavily than the local source in the Superior plantation. These findings add more evidence to show that local sources appear to be better adapted to local weevil populations than other stock. Jack pine appears to respond to white-pine weevil susceptibility just as it does to some other factors of the local environment.

April 1962

H. O. BATZER, Entomologist

1/ Batzer, H. O. 1961. Jack pine from Lake States seed sources differ in susceptibility to attack by the white-pine weevil. Lake States Forest Expt. Sta. Tech. Note 595.

2/ "Work plan for a regional jack pine seed source study in the Lake States" by Paul O. Rudolf and T. Schantz-Hansen, July 7, 1953; on file at the Lake States Forest Experiment Station.

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Table 1.--Mean number of trees weeviled per acre per year in the Chippewa and Superior National Forest plantations, regional jack pine seed source study

State and county of origin	Seed source number	Mean no. of trees weeviled per acre per year: Chippewa N. F. 1958-1959	Superior N. F. 1960-1961
MINNESOTA			
Cass	Local	33.5	--
Lake	Local	--	53.2
Cass	1589	34.4	142.3**
Cass	1590	32.5	74.9
Itasca	1591	26.3	72.2
Lake	1592	33.5	52.1
Cook	1593	36.7	33.0
St. Louis	1594	35.8	78.3
Pine	1595	125.6**	146.0**
Pine	1596	114.1**	104.5
Becker	1597	48.2	141.4**
Cass	1600	47.1	117.3*
Beltrami	1601	30.2	74.9
Itasca	1602	49.8	80.3
WISCONSIN			
Douglas	1604	99.1**	117.3*
Bayfield	1605	12.1	69.6
Forest	1606	50.9	76.9
Oneida	1607	60.3	106.1
Burnett	1608	97.6**	121.5*
Marinette	1609	114.1**	142.3**
Oneida	1610	108.5**	195.0**
Wood	1611	116.5**	212.1**
MICHIGAN			
Gogebic	1612	104.5**	96.9
Ontonagon	1613	47.1	87.4
Alger	1614	56.1	104.5
Chippewa	1615	60.3	67.1
Manistee	1616	44.9	62.1
Ogemaw	1617	56.1	66.5
Alpena	1618	63.3	56.7
Grand Traverse	1620	30.8	24.2
Luce	1621	32.1	99.9

** Significant at the 1-percent level when compared with local source.

* Significant at the 5-percent level when compared with local source.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 619

Stack Drafts Provide Optimum Ignition and Coaling Conditions For Charcoal Production

Using a small blower fan to create a draft in kiln stacks seems to offer the best overall chance for creating accelerated ignition and coaling conditions in charcoal kilns without sacrificing final yields.[1/]

This stack-draft method (fig. 1) is a development of the Lake States Station's charcoal research program carried on at the Argonne Experimental Forest near Three Lakes, Wis.

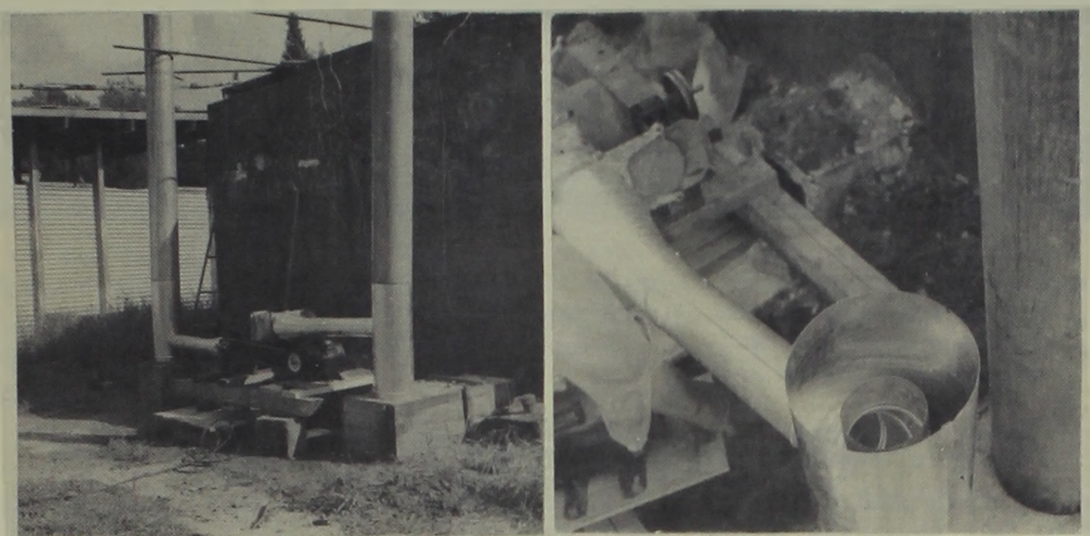

Figure 1.--Stack-draft method. Left, a double-blower fan supplies air to stacks. Right, inside of 8-inch stack at junction of 4-inch pipe from blower fan.

Early acceleration experiments on the Argonne Forest showed that coaling time for air-seasoned sugar maple roundwood could be reduced 40 percent by using four stacks, one placed at each corner of the kiln, and firing the center of the charge.[2/] This method, however, is not satisfactory for carbonizing green wood nor is it acceptable by commercial operators using rectangular-shaped kilns.

With four stacks, it is necessary to use a blower fan at the central combustion chamber since all of the stacks will not draw properly under most atmospheric conditions. This concentration of all of the heat generation at the center tends to burn up more of the charge than does spreading the fuel combustion along one end of the charge. Overburning losses from center firing were greater in green wood than in air-seasoned wood, and the greatest volume losses occurred in green slabs and stovewood.

In our experiments, green sugar maple slabs and stovewood were the most difficult raw materials to carbonize under accelerated coaling conditions. Therefore, nine burns were made with this material in order to compare the end-fired stack-draft method with the center-fired four-stack method and the conventional or end-fired natural-draft method.

All burns were made in experimental composite-wall kilns, and the wood charges averaged 3.5 cords. From these nine burns, the average ignition and coaling times are shown in table 1 and the yields in table 2.

The stack-draft method did not appear to accelerate coaling as much as the center-firing method, but, compared with conventional end firing, it did reduce the coaling cycle 25 percent. During ignition, the stack-draft method is probably superior to all others. Figure 2 compares ignition by the stack-draft and conventional methods.

Charcoal yields from the stack-draft method compared well with those from conventional methods and were considerably better than yields by the center-firing method.

April 1962

JAMES C. WARD, Forest Products Technologist

1/ Method suggested and designed by Harold C. Bell of the Lake States Forest Experiment Station, Argonne Experimental Forest.
2/ Lane, Paul H. Wood carbonization in kilns. Forest Prod. Jour., X:344-348 illus. 1960.

Figure 2.--Left, stack-draft method. Three minutes after ignition all stacks are drawing and there is even combustion across air intake ports. Right, conventional or natural-draft method. Fifteen minutes after ignition only one stack is drawing and smoke is backing up through several air intake ports.

Table 1.--Average ignition and coaling times for green sugar maple slabs and stovewood by method of operation

Operating method	No. of burns	Ignition: Average torch time	Ignition: Average time for all stacks to draw	Coaling time
		Minutes	Minutes	Hours
A-Stack draft, end-fired; fan through 2 stacks	2	3.5	1	21
B-Center-fired; fan through central combustion chamber; 4 stacks	3	12	12	18
C-Conventional end-fired, natural draft; 2 stacks	4	22	90	28

Table 2.--Average yields for green sugar maple slabs and stovewood by method of operation

Operating method	Wood moisture, percent	Charcoal yield: Percent of oven-dry wood weight	Charcoal yield: Percent of green wood volume	Brand volume, 1/ percent of green wood volume
A-Stack draft	55	31.4	42.2	1.4
B-Center-fired	55	22.2	25.0	8.7
C-Conventional	50	30.7	40.5	13.0

1/ Amount of charge that was not completely carbonized.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
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No. 620

Two Prescribed Summer Fires Reduce Abundance and Vigor of Hazel Brush[1] Regrowth

In the spring of 1960 a prescribed burning experiment was begun on the Cutfoot Experimental Forest located in north-central Minnesota. The study was installed beneath a stand of 90-year-old red pine which has an understory of brush. One of the main purposes of the experiment was to compare dormant season with summer burning, and annual with biennial burning. Two annual summer fires have more effectively reduced the vigor and amount of brush than any other burning combination.

Dormant season burning so far has been done only in the spring, either in late April or early May. Summer burning in 1960 was done in July and early August, while in 1961 it was completed on June 6, about 3 weeks after the onset of the growing season which is normally about 15 weeks long.

The brush population per acre before burning for all treatments combined was somewhat variable but averaged 22,800 stems for all height classes; 22,000 stems 12 inches or more in height; and 52.0 cubic feet, which includes the total cubic-foot volume of the stems, branches, and bark of all brush.

In the fall of the year following the second annual fire, measurements were made of all regrowth. The results are given in Table 1.

Table 1.--Number of stems and cubic-foot volume per acre of new growth after prescribed burning as compared to unburned controls.

Season and frequency of burning[1]	Number of stems in thousands: Total	Number of stems in thousands: 12 inches or more in height	Volume in cubic-feet
Once burned			
Spring	53.0	52.2	8.9
Summer	50.2	50.5	2.4
Twice burned			
Spring	81.0	56.5	2.9
Summer	17.6	6.0	0.3
Unburned	19.9	19.8	37.0

1/ Eight observations for each once-burned treatment, four observations for each twice-burned treatment. Analysis of variance run only on total number of stems, omitting the unburned treatment. Spring vs. summer significant at .05 level; summer once vs. summer twice significant at .05 level.

1/ Corylus cornuta and C. americana. The experiment also contains minor quantities of adler (Alnus spp.), willow (Salix spp.), and juneberry (Amelanchier spp.).

Fires easily killed the above-ground portions of all brush regardless of the season of year or frequency of burning. Sprouting or resprouting of the brush followed, and the abundance and massiveness of the sprouts appears to be related to the season and frequency of burning.

Two annual summer fires have reduced the total number of stems per acre below that contained in the original stand (Table 1). All other burning treatments have produced at least twice as many sprouts per acre as there were stems in the original stand; in the case of two annual spring fires, there are nearly four times as many sprouts as original stems.

The vigor and volume of regrowth is also affected by the season and frequency of burning, but the picture is complicated because the summer burns have not had as much time for regrowth as the dormant season burns. For example, the twice-burned spring treatment had 56.5 thousand stems 12 inches or more in height and 2.9 cubic feet of volume per acre at the end of the growing season after the second fire, whereas the twice-burned summer treatment had only 6.0 thousand stems 12 inches or more in height and 0.3 cubic foot of volume per acre. However, the spring treatment had a full growing season, while the growing period for the summer treatment was about 3 weeks less than the normal 15-week season. Similarly, the once-burned spring treatment had 8.9 cubic feet per acre two full growing seasons later while the once-burned summer treatment had 2.4 cubic feet per acre about 1-1/3 growing seasons later.

Two annual summer fires have completely eliminated hazel sprouts from several of the milacre subplots on which measurements were made, a result not achieved by the other treatments shown in Table 1. This effect on distribution, together with the data given on number and vigor of sprouts, suggests that subsequent annual summer fires will continue the deterioration and bring about the eventual elimination of hazel brush.

April 1962

Robert E. Buckman
Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 621

Spruce Budworm Defoliation Causes Continued Top Killing and Tree Mortality in Northeastern Minnesota

The area of spruce-fir type severely defoliated by the spruce budworm continues to increase in northeastern Minnesota (fig. 1). The 1961 aerial defoliation survey showed 240,000 acres of spruce-fir type in this condition, as compared with 96,000 acres observed in 1960. Severe defoliation is evidenced by a grayish appearance over the entire tree and is the result of 3 or more years of heavy defoliation of the new growth. These stands are characterized by extensive top killing and tree mortality.

During September 1960, 16 permanent sample plots were installed in the severely defoliated area to determine the amount of top killing and tree mortality actually occurring.[1] Fourteen of these plots were remeasured during September 1961, and one additional plot was also installed.

In the area classified as severe it was found that:

1. Balsam fir mortality during 1961 in trees 4 inches d.b.h. and larger averaged 1.4 cords per acre.[2] Some plots lost as much as 4.8 cords per acre.

2. Balsam fir mortality thus far during the budworm epidemic averages 2.3 cords per acre. This constitutes 16 percent of the original plot volumes.[3] Most of the mortality occurred in small patches.

3. Top killing of 2 or more feet now occurs in 34 percent of the merchantable-sized balsam still living.

4. Balsam trees less than 4 inches d.b.h. averaged 18 percent mortality during 1961. Cumulative mortality now averages 29 percent.

5. Very little top killing or tree mortality occurs in white spruce.

Except for obvious mechanical damage, it was not possible in this survey to separate natural mortality from that directly caused by the budworm. This will be reported upon in a later paper. Natural mortality, however, during only 1 year would generally be low.

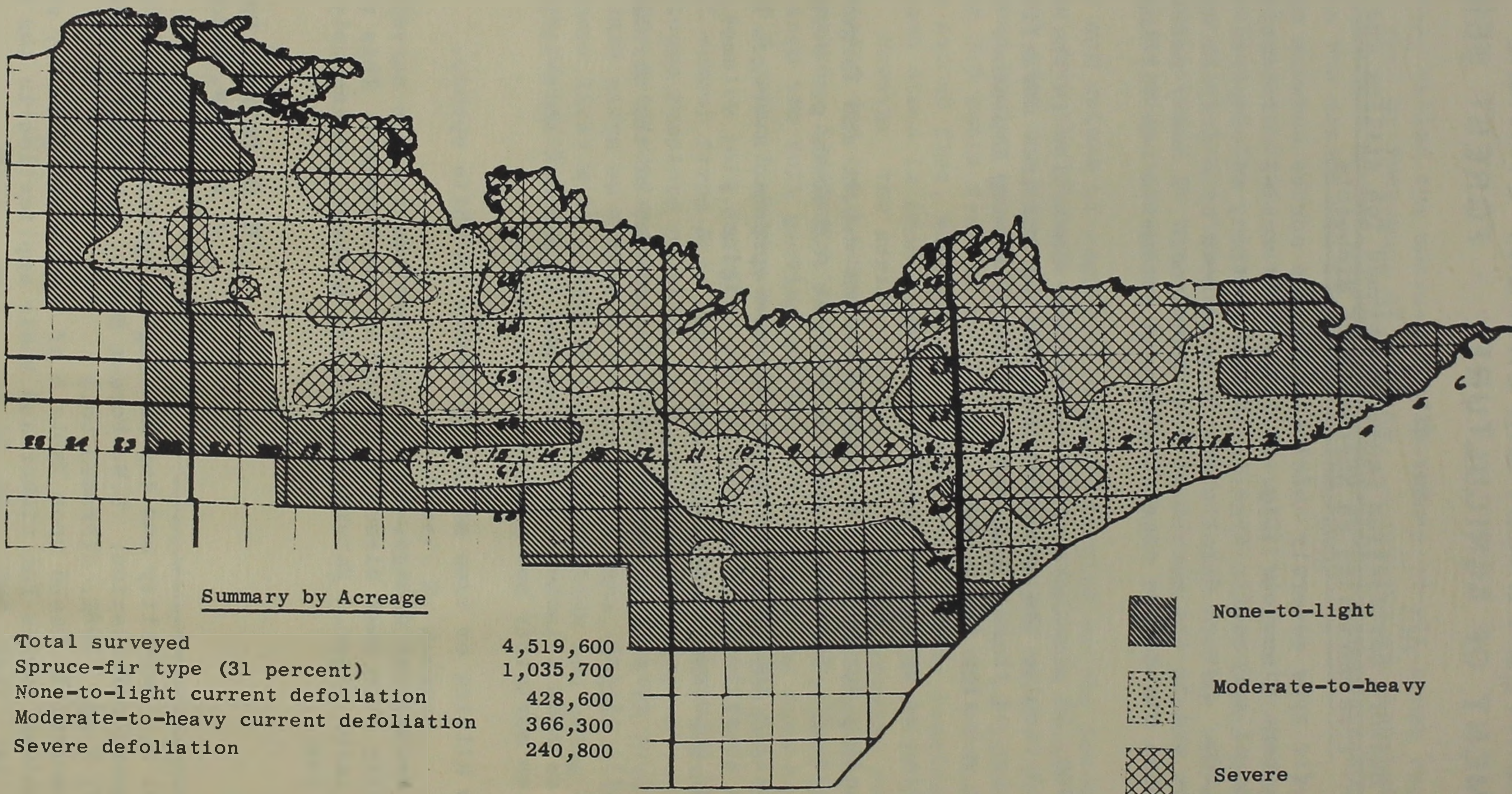
H. O. BATZER, Entomologist
J. L. BEAN, Entomologist

April 1962

1/ Schmiege, D. C. Mortality and top killing of spruce-fir caused by repeated spruce budworm defoliation. U.S. Forest Serv., Lake States Forest Expt. Sta. Tech. Note 597, 2 pp. 1961. (Processed.)

2/ Volumes of mortality based upon Table 6 of Gevorkiantz, S. R., and L. P. Olsen. Composite volume tables for timber and their application in the Lake States. U.S. Dept. Agr. Tech. Bul. 1104, 51 pp., illus. 1955.

3/ Original volume based upon the stand volume equation: Cords = .003958 B·H as reported by R. E. Buckman. Development and use of three stand volume equations for Minnesota. Jour. Forestry 59: 573-575, illus. 1961.



Summary by Acreage

Total surveyed	4,519,600
Spruce-fir type (31 percent)	1,035,700
None-to-light current defoliation	428,600
Moderate-to-heavy current defoliation	366,300
Severe defoliation	240,800

Figure 1.--Spruce budworm defoliation in northeastern Minnesota, based on the 1961 aerial survey.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 622

Volume and Use of Wood Residues From Primary Processing in Minnesota

Wood residues from sawmills and other log-using plants are frequently proposed as a source of raw material for making paper, paperboard, felt, charcoal, and other products. Two questions posed by potential buyers are, "How much of these residues is produced annually?" and "What becomes of them?" Answers to these questions have been acquired during the course of the current Minnesota Forest Survey. The profitability of using any of these materials would, of course, have to be determined for any proposed salvage operation.

Station estimates based on survey findings1/ show that approximately 165,000 cords of coarse and fine residues were developed at Minnesota primary wood-using plants in 1960 (see table 1). Sawmills accounted for about 90 percent of residue; veneer, cooperage, and lath mills accounted for the remaining 10 percent. Coarse, chippable residue amounted to nearly 90,000 cords in 1960. Not all of this material was discarded, however. More than half of it was consumed as industrial and domestic fuel and about 5 percent was taken for charcoal and other uses (see table 2). At present, none of the residue is used for pulping. It is estimated that 32,000 cords of chippable residue went unused in 1960.

Northern counties accounted for about 70 percent of the mill residue developed in the State. St. Louis, Itasca, and Beltrami Counties had the largest amounts (see table 3).

Table 1.--Volume of residues developed at primary wood-using plants, Minnesota, 1960.

(In thousand cords)1/

Kind of mill and species group	Coarse residue 2/			Fine residue 3/		
	State total	Northern counties	Southern counties	State total	Northern counties	Southern counties
Sawmills						
Softwoods	34	32	2	29	28	1
Hardwoods	45	23	22	41	21	20
Total	79	55	24	70	49	21
Veneer and cooperage mills						
Softwoods	-	-	-	-	-	-
Hardwoods	2	*	2	3	1	2
Total	2	*	2	3	1	2
Match, lath, and shingle mills						
Softwoods	1	1	-	1	1	-
Hardwoods	5	5	*	4	4	*
Total	6	6	*	5	5	*
All mills						
Softwoods	35	33	2	30	29	1
Hardwoods	52	28	24	48	26	22
Total	87	61	26	78	55	23

(Table footnotes appear on bottom of next page)

1/ These estimates are based on information collected in 1961 from two sources: State forestry agencies and county land commissions contacted sawmills; the Station contacted other primary wood-using plants.

Table 2.--Disposition of this plant residue by area and species group.

(In thousand cords)1/

Disposition	Coarse residue 2/ State total	Coarse residue 2/ Northern counties	Coarse residue 2/ Southern counties	Fine residue 3/ State total	Fine residue 3/ Northern counties	Fine residue 3/ Southern counties
Softwoods						
For fiber	-	-	-	-	-	-
For fuelwood	16	14	2	4	4	*
For other uses 4/	2	2	-	4	4	-
Not used	17	17	-	22	21	1
Total	35	33	2	30	29	1
Hardwoods						
For fiber	-	-	-	-	-	-
For fuelwood	35	15	20	7	6	1
For other uses 4/	2	*	2	19	3	16
Not used	15	13	2	22	17	5
Total	52	28	24	48	26	22
All species						
For fiber	-	-	-	-	-	-
For fuelwood	51	29	22	11	10	1
For other uses 4/	4	2	2	23	7	16
Not used	32	30	2	44	38	6
Total	87	61	26	78	55	23

Table 3.--Volume of plant residue produced, used, and not used in northern counties, 1960.

(In thousand cords)1/

County and survey district	Coarse residue 2/ Produced	Coarse residue 2/ Used	Coarse residue 2/ Wasted	Fine residue 3/ Produced	Fine residue 3/ Used	Fine residue 3/ Wasted
Carlton	5	4	1	5	4	1
Cook	3	*	3	2	*	2
Lake	3	*	3	3	-	3
Pine	1	1	*	*	*	*
St. Louis	11	2	9	10	1	9
Northeast District	23	7	16	20	5	15
Aitkin	4	3	1	3	-	3
Becker	2	2	*	2	-	2
Beltrami	6	5	1	5	3	2
Cass	4	2	2	4	2	2
Clearwater	3	2	1	3	2	1
Crow Wing	3	2	1	2	-	2
Hubbard	3	2	1	3	1	2
Itasca	8	3	5	8	3	5
Wadena	1	1	-	1	-	1
Central Pine District	34	22	12	31	11	20
Koochiching	3	1	2	3	1	2
Lake of the Woods	1	1	*	1	*	1
Rainey River District	4	2	2	4	1	3
Northern county total	61	31	30	55	17	38

1/ 79 cubic feet (bark free) wood per cord.
2/ Material suitable for chipping, such as slabs, edgings, veneer cores, etc.
3/ Material not suitable for chipping, such as sawdust, shavings, etc.
4/ Charcoal, small dimension, specialty items, livestock bedding, mulch, meat curing, etc.
* Less than 500 cords.

APRIL 1962

ARTHUR G. HORN, Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 623

Minnesota Produces 161 Million Board Feet of Lumber--1960.

A comprehensive survey of 1960 lumber production was completed in Minnesota last year through the combined efforts of the Office of Iron Range Resources and Rehabilitation, the State Division of Forestry, and several county Land Commissioners and staff. The sawmill output data were turned over to the Station for summarizing. The resulting estimates of lumber production by species and counties should be of value to forestry agencies, timber industries, and various other groups.

Results of the survey show that Minnesota sawmills produced about 161½ million board feet of lumber in 1960. This is 18 percent less than was produced in 1953, the most recent year for which a similar survey was made. The decline in lumber output was most pronounced in the Central Pine District (see following table). The slump in production was due in part to closure of several rather large mills in the area.

As in other years, St. Louis and Itasca Counties were the largest lumber producing counties (see table reverse side).

The 1960 lumber output of nearly all species was less than in 1953. Jack pine and aspen in particular were down, declining 35 and 25 percent respectively.

Production of lumber by species and districts,[1/] Minnesota, 1960
(In thousand board feet, lumber tally)

Species	Northeast District	Central Pine District	Rainy River District	Hardwood District	Prairie District	State total
Balsam fir	1,740	1,909	453	49	22	4,173
Cedar	1,308	191	489	3	58	2,049
Jack pine	4,713	15,026	815	531	2,158	23,243
Red pine	4,411	10,143	378	564	27	15,523
White pine	9,895	9,257	820	1,372	84	21,428
Black spruce	25	7	105	33	-	170
White spruce	1,234	546	424	160	298	2,662
Tamarack	80	590	197	232	195	1,294
Total softwoods	23,406	37,669	3,681	2,944	2,842	70,542
Ash	455	1,816	352	1,264	338	4,225
Aspen	10,206	20,582	2,729	2,445	1,624	37,586
Basswood	269	2,257	54	5,578	781	8,939
Yellow birch	728	73	30	26	18	875
White birch	2,178	926	157	59	38	3,358
Cottonwood	-	-	1	1,216	3,777	4,994
Elm	218	1,000	99	5,941	1,617	8,875
Hickory	-	-	-	12	2	14
Hard maple	106	9	-	382	90	587
Soft maple	27	95	-	1,356	102	1,580
Red oak	276	1,402	-	11,986	819	14,483
White oak	10	357	44	1,969	1,721	4,101
Walnut	-	-	-	193	41	234
Balsam poplar	-	619	1	102	8	730
Butternut	-	2	-	162	2	166
Other	-	-	-	46	8	54
Total hardwoods	14,473	29,138	3,467	32,737	10,986	90,801
All species	37,879	66,807	7,148	35,681	13,828	161,343
Percentage change from 1953[2/]	-12	-31	+7	-5	+15	-18

(Footnotes appear at bottom of next page)

(Over)

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

Lumber production for specified counties, 1960

(In thousand board feet, lumber tally)

County and district	Number of active mills	Production by species groups			
		All species	Softwoods	Aspen	Other hardwoods
Carlton	40	1,906	1,212	338	356
Cook	22	5,418	1,990	1,529	1,899
Lake	25	5,864	4,337	1,239	288
Pine	15	1,081	170	188	723
St. Louis	190	23,610	15,697	6,912	1,001
Northeast District	292	37,879	23,406	10,206	4,267
Aitkin	42	7,417	901	3,182	3,334
Becker	36	4,253	3,184	801	268
Beltrami	46	12,576	7,628	3,939	1,009
Cass	50	9,301	7,262	1,457	582
Clearwater	38	5,925	1,849	2,998	1,078
Crow Wing	26	5,671	3,264	1,970	437
Hubbard	25	4,171	3,714	446	11
Itasca	83	16,285	8,683	5,781	1,821
Wadena	23	1,208	1,184	8	16
Central Pine District	369	66,807	37,669	20,582	8,556
Koochiching	35	5,809	2,682	2,390	737
Lake of the Woods	13	1,339	999	339	1
Rainy River District	48	7,148	3,681	2,729	738
Hardwood District 3/	(4/)	35,681	2,944	2,445	30,292
Prairie District 3/	(4/)	13,828	2,842	1,624	9,362
State total	(4/)	161,343	70,542	37,586	53,215

1/ Survey method: A complete canvass of sawmills was made in 17 northern counties. These counties normally account for about 70 percent of the total State lumber output. A stratified random area sample was used for the remaining part of the State. The standard error of the lumber estimate is less than 10 percent. Sawmill data in the northern counties were collected by the Office of Iron Range Resources and Rehabilitation personnel and the Land Commissioners and staff in Aitkin, Becker, Beltrami, Cass, Clearwater, Crow Wing, Itasca, and Koochiching Counties. In the southern and western counties sawmill data were collected by Service Foresters employed by the State Division of Forestry.

Because of a difference in survey sampling procedure the Statewide lumber production estimate shown here may differ slightly from the official Federal Government estimate which is not yet available from the Bureau of the Census.

2/ Latest year lumber production figures (by district) are available.

3/ County information not available for Hardwood and Prairie Districts

4/ Not available.

Arthur G. Horn,
Research Forester

July 1962

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 624

Production and Imports of Pulpwood Decline in the Lake States, 1961

Pulpwood production in the Lake States, which has been rising almost without interruption since 1953, gave ground in 1961 with the output dropping below that of the previous year. The Lake States harvest amounted to approximately 3,152,000 cords, 6 percent less than the all-time high of 3,337,000 cords cut in 1960.

Wisconsin production registered a slight increase while Michigan and Minnesota fell below the level of the previous year. Michigan remains the leading pulpwood producing State in the Region by a scant margin of some 20,000 cords.

Production of most species showed decreases from the previous year. The cut of tamarack, balsam fir, and aspen declined the most, dropping 34, 14, and 9 percent, respectively. Despite the general downward trend, white birch and miscellaneous dense hardwoods registered gains of 40 and 14 percent, respectively. The maples, oaks, and other dense hardwoods were cut more heavily for pulpwood than ever before.

Local demand for plant residues and wood chips amounted to nearly 25,000 cords in 1961, almost double that of 1960. At the present time, local use of such material is limited to five Wisconsin mills. Exports of wood chips and plant residues to other States remained unchanged.

Total 1961 pulpwood receipts at Lake States mills were about 3½ million cords, a decrease of 7 percent from the previous year. Receipts at Michigan and Wisconsin mills were down 14 percent and 7 percent respectively; those of Minnesota mills remained unchanged. Lake States forests supplied 90 percent of the pulpwood received, Canada 9 percent, and Western States 1 percent (see table below).

The table on the reverse side is a record of pulpwood production, imports, and exports for the Lake States, by species.

Geographic origin and destination of pulpwood received
by Lake States mills, 1961

Species	Percent of pulpwood originating from:					Percent of pulpwood received by mills in:		
	Minn.	Wis.	Mich.	Canada	Other U. S.	Minn.	Wis.	Mich.
Aspen	25	36	38	1	-	26	50	24
Balsam fir	35	19	36	10	-	21	57	22
Birch	3	66	31	-	-	3	85	12
Hemlock	-	52	48	-	-	-	100	-
Pine	33	24	25	11	7	30	53	17
Spruce	43	4	18	35	-	22	64	14
Tamarack	41	37	22	-	-	-	100	-
Misc. hardwoods 1/	10	61	29	-	-	11	61	28
Slabs, etc.	-	67	33	-	-	-	100	-
Wood chips	-	35	65	-	-	-	100	-
All wood material	28	31	31	9	1	23	57	20
Previous year (1960)	28	28	33	9	2	21	57	22

1/ Mostly dense hardwoods

July 1962 (Over) A. G. Horn, Research Forester

Production and imports of pulpwood, Lake States, 1961

(In standard cords, unpeeled)

Species and destination	Production by states 1/				Imports			
	Minnesota	Wisconsin	Michigan	Region	Other U. S. 2/	Canada	Total imports	Total receipts
Aspen								
Minn.	351,603	14,144	-	365,747	-	9,214	9,214	374,961
Wis.	16,907	515,548	208,181	740,636	-	-	-	740,636
Mich.	-	423	350,119	350,542	-	-	-	350,542
Total	368,510	530,115	558,300	1,456,925	-	9,214	9,214	1,466,139
Balsam fir								
Minn.	63,309	-	-	63,309	-	4,158	4,158	67,467
Wis.	41,645	60,668	74,894	177,207	-	26	26	177,233
Mich.	-	102	39,708	39,810	-	27,941	27,941	67,751
Exported 3/	5,596	-	-	5,596	-	-	-	-
Total	110,550	60,770	114,602	285,922	-	32,125	32,125	312,451
Birch, white								
Minn.	1,392	-	-	1,392	-	-	-	1,392
Wis.	71	33,961	9,767	43,799	-	-	-	43,799
Mich.	-	-	6,291	6,291	-	-	-	6,291
Total	1,463	33,961	16,058	51,482	-	-	-	51,482
Hemlock								
Minn.	-	-	-	-	-	-	-	-
Wis.	-	47,498	44,114	91,612	-	-	-	91,612
Mich.	-	-	247	247	-	-	-	247
Total	-	47,498	44,361	91,859	-	-	-	91,859
Pine								
Minn.	146,229	208	-	146,437	-	40,600	40,600	187,037
Wis.	59,259	154,140	46,712	260,111	44,027	26,164	70,191	330,302
Mich.	-	-	108,991	108,991	-	-	-	108,991
Total	205,488	154,348	155,703	515,539	44,027	66,764	110,791	626,330
Spruce								
Minn.	115,951	-	-	115,951	-	3,804	3,804	119,755
Wis.	114,642	22,935	64,710	202,287	-	147,502	147,502	349,789
Mich.	-	13	31,660	31,673	-	43,273	43,273	74,946
Exported 3/	9,845	-	-	9,845	-	-	-	-
Total	240,438	22,948	96,370	359,756	-	194,579	194,579	544,490
Tamarack								
Minn.	-	-	-	-	-	-	-	-
Wis.	7,808	6,876	4,187	18,871	-	-	-	18,871
Mich.	-	-	-	-	-	-	-	-
Total	7,808	6,876	4,187	18,871	-	-	-	18,871
Misc. dense hdwds.								
Minn. 4/	33,851	-	-	33,851	-	-	-	33,851
Wis. 4/	-	191,391	4,543	195,934	-	-	-	195,934
Mich. 4/	-	-	90,886	90,886	-	-	-	90,886
Exported 3/	-	9,200	-	9,200	-	-	-	-
Total	33,851	200,591	95,429	329,871	-	-	-	320,671
Total roundwood								
Minn.	712,335	14,352	-	726,687	-	57,776	57,776	784,463
Wis.	240,332	1,033,017	457,108	1,730,457	44,027	173,692	217,719	1,948,176
Mich.	-	538	627,902	628,440	-	71,214	71,214	699,654
Exported 3/	15,441	9,200	-	24,641	-	-	-	-
Total	968,108	1,057,107	1,085,010	3,110,225	44,027	302,682	346,709	3,432,293
Slabs, etc.								
Minn.	-	-	-	-	-	-	-	-
Wis.	-	10,578	4,967	15,545	-	-	-	15,545
Mich.	-	-	-	-	-	-	-	-
Exported 3/	-	3,128	1,920	5,048	-	-	-	-
Total	-	13,706	6,887	20,593	-	-	-	15,545
Wood chips								
Minn.	-	-	-	-	-	-	-	-
Wis.	-	6,401	1,881	8,282	-	-	-	8,282
Mich.	-	-	-	-	-	-	-	-
Exported 3/	-	1,174	12,064	13,238	-	-	-	-
Total	-	7,575	13,945	21,520	-	-	-	8,282
All wood material								
Minn.	712,335	14,352	-	726,687	-	57,776	57,776	784,463
Wis.	240,332	1,049,996	463,956	1,754,284	44,027	173,692	217,719	1,972,003
Mich.	-	538	627,902	628,440	-	71,214	71,214	699,654
Exported 3/	15,441	13,502	13,984	42,927	-	-	-	-
Total	968,108	1,078,388	1,105,842	3,152,338	44,027	302,682	346,709	3,456,120

1/ Vertical columns of figures under box heading "Production by States" present the amount of pulpwood cut in each State.

2/ Mostly Western States.

3/ Pulpwood shipped to mills outside of Region.

4/ Some balsam poplar (Balm-of-Gilead) in Minnesota, mostly dense hardwoods in other States.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 625

Snow Damage Is Correlated With Stand Density in Recently Thinned Jack Pine Plantations

Most Lake States plantation species are resistant to snow damage; but an exceptionally heavy, wet snowfall may cause severe damage to a jack pine plantation that has been recently thinned. These storms occur infrequently and jack pine stands tend to become less susceptible to damage within a few years after thinning.[1/] However, the possibility of heavy storms and the severe damage they can cause should be considered in the initial thinning of a stand.

In April, 1961, a storm damaged two southwestern Michigan jack pine plantations containing experimental cuttings. Only one growing season had elapsed since the plantations were thinned in a number of different treatments. The treatments are described below, and the types and intensity of damage inflicted in the various treatment areas are discussed.

Two 24-year-old jack pine plantations on the Allegan State Forest in Allegan County were thinned in the fall of 1959. Both stands were on good sites, averaging slightly under 120 square feet of basal area per acre before thinning. The average stand diameter was 4.8 inches. The stands were thinned to leave 30, 60, 90, and 120 square feet per acre on 0.4-acre cutting compartments. Thinning was primarily from below, but only trees 4.0 inches and larger were removed.

Additional plots were left for later thinning to higher densities as the stand develops. In addition, three compartments were established in which every second row was cut. In three other compartments every third row was cut. These two treatments left about 64 and 85 square feet of basal area per acre, respectively.

Ten inches of wet snow accompanied by gusty winds fell on the stands on April 16-17, 1961. According to local weather station records, the snowfall equalled 1.19 inches of water. Of this, about 0.90 inches fell on the 16th. Temperatures during the 2-day period ranged from 29 to 37 degrees.

The frequency of tree damage decreased as the residual basal area increased for both cutting methods (fig. 1). The amount of damage tended to level off above 90 square feet in the compartments thinned from below where the basal area cut was relatively light. Roughly twice as many trees were damaged in the row-thinned compartments as in those thinned from below for comparable levels of basal area. In all treatments about 7 percent of the damaged trees had two or more types of injury.

The number of trees damaged per acre decreased slightly as the residual basal area increased, ranging from 145 trees per acre in the 30-square foot level to about 120 trees in the uncut portion of the stand. Approximately 200 trees per acre were damaged in the row-thinned plots. The exposed edges of the plantations, particularly those with openings to the south or west, apparently had more snow damage than the interior of the stand.

The types of damage--stem, limb, and root breakage or snow-bent stems--did not show a consistent relationship to the basal area of the compartments thinned from below (fig.2).

Stem breakage, occurring primarily in trees of average stand diameter and larger, accounted for about three-fifths of the damage to the residual stand. The point of breakage in the heavier thinnings appeared to be random along the stem at heights from 4 to 15 feet above the ground. Breakage occurred near the base of the crown in the lightly thinned and uncut plots. Less than 3 percent of the breakage occurred in the upper two-thirds of the crown.

Limb breakage, which occurred on the largest residual trees, was relatively minor in all treatments.

The percent of rootsprung and uprooted trees decreased with an increase in residual stand density and was confined to the larger diameter classes.

The proportion of snow-bent trees increased with residual basal area. Slightly more than half of these trees, primarily those of average stand diameter and smaller, were bent more than 40 degrees.

In the row-thinned plots stem breakage and uprooting, occurring in all size residual trees, accounted for about 90 percent of the damage. Stem breakage was highest where every third row was cut, causing nearly 60 percent of the total damage. Uprooting comprised nearly 50 percent of the damage where every second row was cut. Uprooting generally occurred in groups within the rows and in adjacent leave rows. Limb breakage was negligible under both thinning methods.

1/ Roe, E. I., and J. H. Stoeckeler. Thinning over-dense jack pine seedling stands in the Lake States. Jour. Forestry 48: 861-865, illus. 1950.

Snow damage tended to be light in unthinned jack pine and Scotch pine stands in the vicinity. A thinned red pine plantation of similar age and site quality was essentially uninjured during the same storm. Cutting methods and residual basal area levels were identical. This indicates a greater resistance of red pine to snow damage.

July 1962

R. M. Godman, Research Forester
Lake States Forest Experiment Station

R. L. Olmstead, Regional Forester
Michigan Department of Conservation

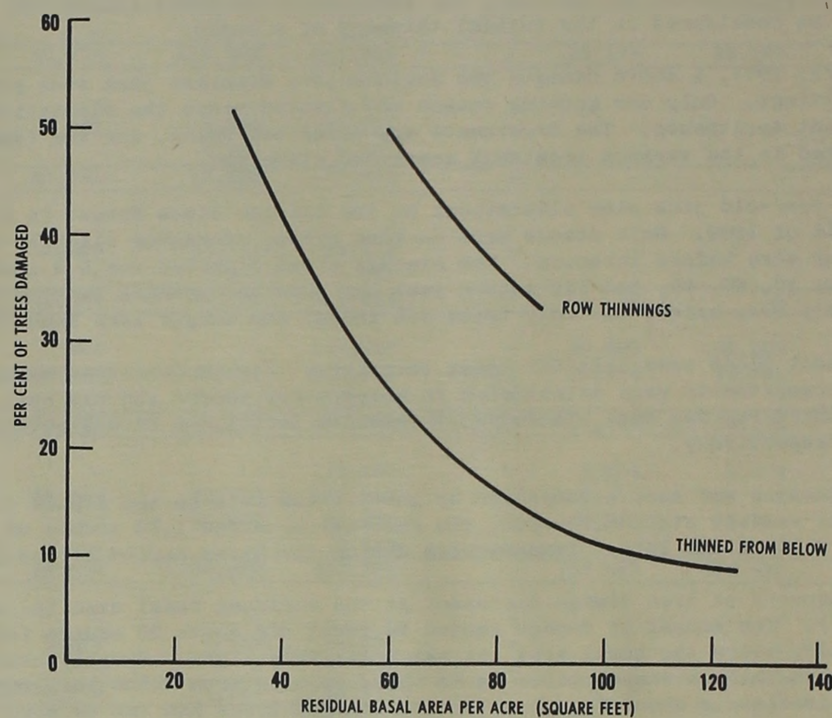


Figure 1.--Frequency of snow damage as related to residual stocking level and method of cutting in thinned jack pine plantations. Storm of April 16-17, 1961, Allegan State Forest.

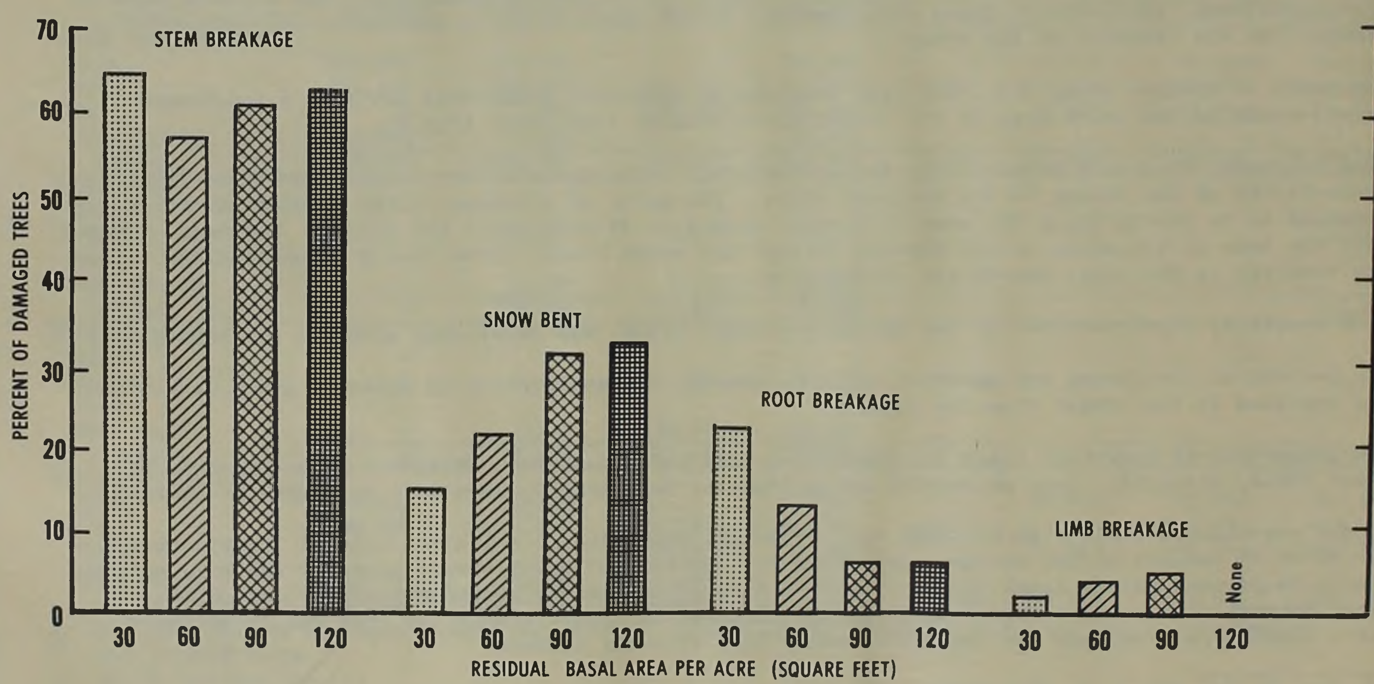


Figure 2.--Type of snow damage in jack pine plantations thinned from below, by residual basal area density. Some trees had two or more types of damage.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 626

Production of Charcoal and Charcoal Briquettes--Lake States, 1961

Charcoal manufacturers have been welcome users of low-grade hardwoods and sawmill residues in the Lake States. But a complete canvass of 1961 charcoal and charcoal briquette production in Minnesota, Wisconsin, and Michigan indicates that these products continue to be only a minor use of poor-quality timber. Temporarily, at least, the upward trend in regional production has ceased.

In 1961, 15 producers (3 more than in 1956) manufactured 67,122 tons of charcoal, 31 percent less than in 1956. By State the production totaled 1,291 tons in Minnesota, 7,078 tons in Wisconsin, and 58,753 tons in Michigan. The decrease in production may be accounted for to some extent by the closing of a large Michigan plant in September 1961 and by competition from lignite charcoal made in Canada and North Dakota.

Jobbers, industrial users, and briquetting plants bought 12,171 tons; the remaining material was stored or used for briquetting in integrated companies. More than half of the sales were to briquetting plants. Sales to jobbers and industrial users were off sharply from 1956 figures.

A total of 93 kilns and retorts, including three continuous process kilns, are available for use by active plants. More than half are in the 1 to 5 ton size-class (see table 1). Total potential annual capacity is 100,000 tons based on a 310-day operating year (see table 2). With this capacity potential annual raw wood use is approximately 250,000 cords.

Four briquette plants manufactured 61,091 tons during 1961. Briquette sales totaled 60,875 tons--jobbers bought 40,890 tons, chain stores 15,960 tons, and others 4,025 tons. Twelve percent of the charcoal used was purchased; the balance was produced by the the briquette manufacturers.

The data presented here were gathered as part of an intensive canvass of the Lake States wood-charcoal industry. Some production statistics are not shown, because to do so would reveal data on individual plants.

July 1962 James E. Blyth, Research Forester

(Over)

Table 1.--Number of kilns by State and size-class--1961 1/

State	Size-class (tons of charcoal per carbonizing cycle)				Total kilns
	Under 1	1 - 5	6 - 25	Over 25	
Minnesota	-	4	7	-	11
Wisconsin	-	27	14	11	52
Michigan	4	22	1	-	27
Total all states	4	53	22	11	90

1/ Excludes continuous process kilns.

Table 2.--Number of kilns and potential annual capacity by State and type of kiln, 1961 1/

State	Brick		Concrete or masonry block		Steel (beehive)		Other		Total potential capacity
	Kilns	Potential capacity	Kilns	Potential capacity	Kilns	Potential capacity	Kilns	Potential capacity	
	Number	Tons	Number	Tons	Number	Tons	Number	Tons	Tons
Minnesota	-	-	4	891	-	-	7	1,492	2,383
Wisconsin	11	11,244	41	10,475	-	-	1	246	21,965
Michigan	-	-	-	-	4	310	2/ 25	75,392	75,702
Total, all States	11	11,244	45	11,366	4	310	33	77,130	100,050

1/ Potential annual capacity is defined as the quantity of charcoal that could be produced in a 310-day operating year. Number of kilns includes three continuous process kilns.
2/ Retorts.

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 627

Some Forest Overstory Effects on Microclimate and Related White Pine Blister Rust Spread [1/]

White pine (Pinus strobus L.) blister rust control through eradication of the alternate host is difficult in the northern portion of the Lake States because the cool weather during wet periods favors long-distance spread from Ribes (gooseberries and currants) to white pines. It has been noted that blister rust cankers (caused by Cronartium ribicola Fischer) were less common on eastern white pine under aspen overstories than in the open and that this seemed to be correlated with low available moisture on the needles.[2/]

The effect of crown covers on microclimate under the leaf canopies was investigated with the idea of using microclimates unfavorable to rust spread as an aid to control through climatic escape. The study reported here is a preliminary investigation into measurement of overstory densities, correlated microclimates, and related blister rust incidence on understory pines.

In 1959 the temperature and relative humidity under four densities of aspen were compared to those of an open grass site (with scattered pine seedlings) by locating hygrothermographs in shelters with bottoms 18 inches from the ground at each site. The accuracy of temperatures was maintained within 1° F. by matched thermometers kept in the shelters and checked weekly. Relative humidity was kept within 5 percent accuracy by weekly checks with a sling psychrometer. Each 1/100th-acre plot had about the same number of tree stems in the overstory. The plot with the heaviest density had a two-story canopy of aspen and maple, but no pine understory.

Climatic modifications caused by tree-crown covers varied with seasons. August is the most important period in the spread of blister rust from Ribes to pine. The average weather conditions from August 13 to August 22, 1959, have been chosen as an example of a typical comparison of microclimate on the aspen sites and in the open. Data obtained during 1956 to 1960 under other densities and other tree species have given similar results.

Light.--Total light (average of measurements with light meter facing north and south at breast height) decreased steadily with the subjective density of the crowns (fig. 1). Vertical light (measured by a light meter at the bottom of a vertical mailing tube at breast height) gave a fairly good correlation with subjective density.

Temperature.--Except for the shortest aspen, as crown density increased daily maximum temperatures decreased, and cool periods were generally longer (fig. 2). Minimum night temperatures were highest under medium-density crowns; under greater densities the minimum temperature decreased to equal that in the open. The lowest crown density had a net warming effect, the greatest crown density had a net cooling effect, and medium-density canopies had the effect of reducing diurnal temperature variation.

Humidity.--Except for the greatest density, relative humidities were lower and saturated air periods shorter under denser tree canopies (fig. 2). However, during periods with frequent rains it was wetter under the trees. The site with short aspen was wettest (some rain in the period). The high-density stand with a two-story canopy of aspen and maple was consistently wetter when compared to single-canopied stands. In single-canopied stands daily relative humidities were generally lower and periods of saturated air shorter as stand densities increased; exceptions occurred in some very rainy periods.

Blister rust incidence.--The number of cankers per white pine tree decreased as the density of the overstory increased (fig. 2). As would be expected in a region where temperature was generally favorable to rust spread, there was no apparent correlation with temperature. The incidence of rust on pine seemed to correlate fairly well both with periods of saturated air and with daytime relative humidity.

1/ This note is a condensation of a paper with the same title presented at the Fourth Conference on Agricultural Meteorology, Nov. 28, 1961. See Abstract in Bul. Amer. Met. Soc. 42 (1961): 739-740.

2/ Van Arsdel, E. P. Growing white pine in the Lake States to avoid blister rust. Lake States Forest Expt. Sta., Sta. Paper 92. 1961.
Also Van Arsdel, E. P., and Riker, A. J. Climatic relations of white pine blister rust. In Ann. Rpt. on Diseases of Forest Trees, Univ. Wis., pp. 5-7. 1958.

OCTOBER 1962

E. P. VAN ARSDEL, Plant Pathologist

MAINTAINED AT ST. PAUL 1, MINNESOTA, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA

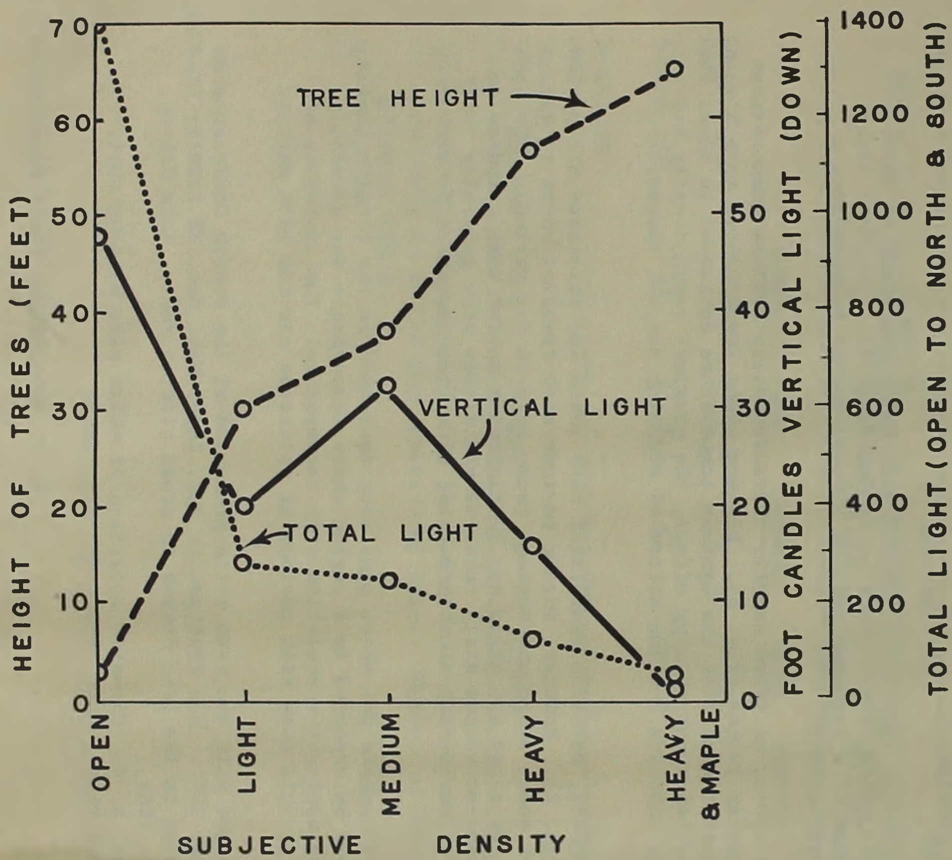


Figure 1.--Comparison of amount of light under four densities of aspen crown canopy on an open grass site. Light is inversely correlated with tree height. (In this chart, each trend line must be read against its own Y-axis. The purpose of the chart is to compare general trends rather than actual figures.)

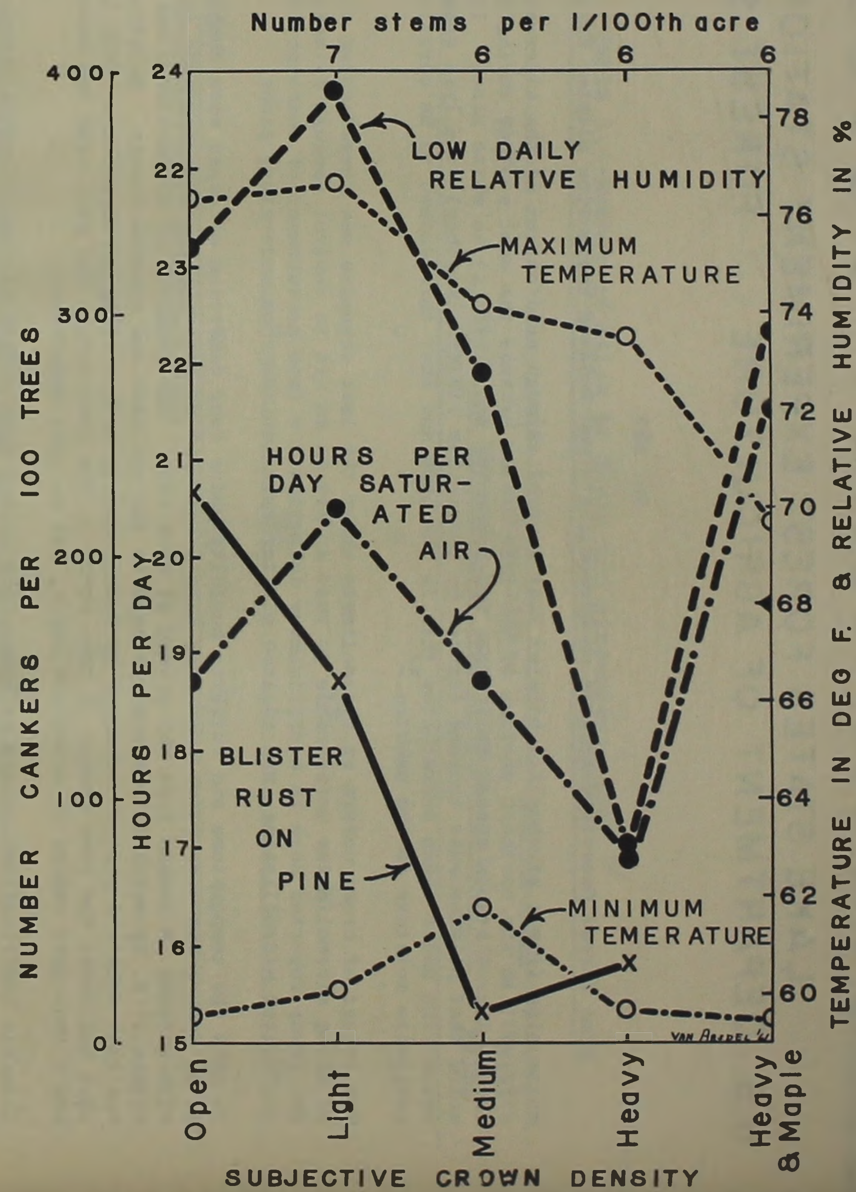


Figure 2.--Incidence of blister rust on pine compared to several meteorological factors by crown density of the overstory. (As in fig. 1, each trend line is to be read against its own Y-axis.)

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 628

Red Pine Cone Production Stimulated by Heavy Thinning

Cone and seed production of red pine, though related to many factors, is influenced to a great extent by stand density. Binocular counts of the 1961 cone crop in a twice-thinned, 51-year-old red pine plantation show that the percentage of trees bearing cones and the number of cones per tree are directly related to the residual stocking (fig. 1).

The thinning experiment was established the fall of 1951 in a medium-site plantation on the Au Sable State Forest in Crawford County, Mich. This was done in cooperation with the Michigan Department of Conservation. The plantation was planted on an abandoned field in 1912. Original spacing was 4½x5 feet. Before thinning, the stand had an average diameter of 5.0 inches and averaged about 180 square feet of basal area per acre. Six thinning compartments were established, and the initial stocking was reduced to residual densities of 60, 80, 100, 120, 140, and 160 square feet. These compartments were rethinned in the fall of 1956 to the same densities.

In all compartments the smallest trees and the poorer quality trees in all size classes were removed until the prescribed stand density was obtained. After the second thinning, all residual trees were in the codominant or dominant crown class except those in the 160-square-foot density compartment where 10 percent were in the intermediate crown class.

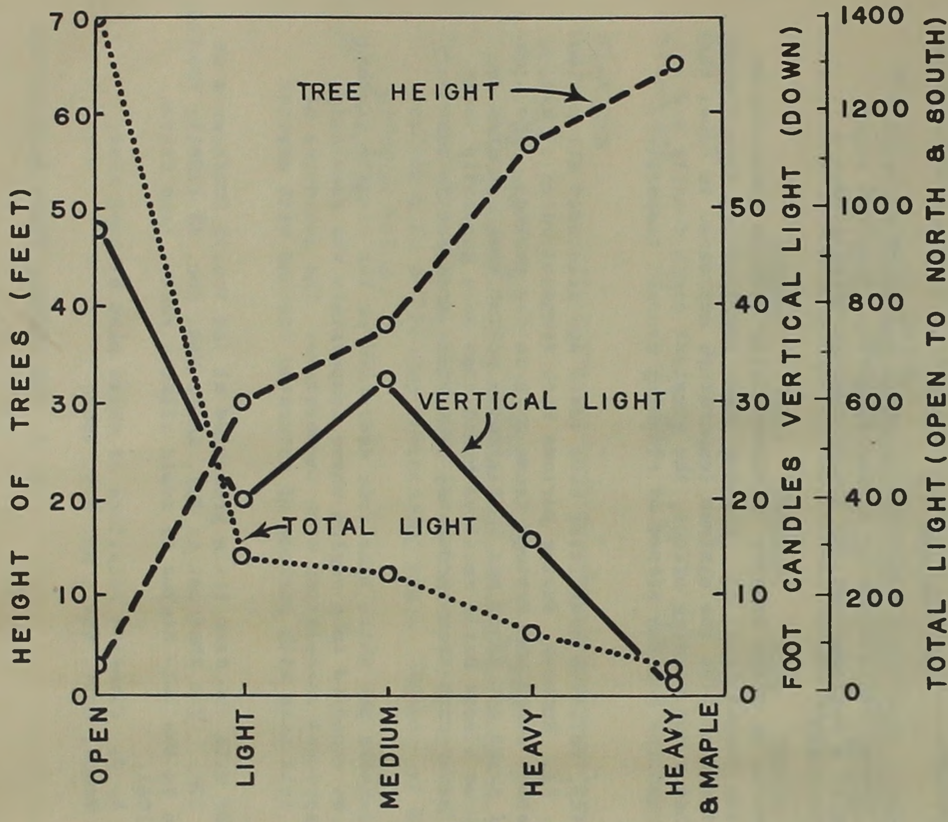
In the fall of 1961, rated as a poor seed year for red pine, all trees on one plot in each density level were checked for presence of cones. Total cone counts were made by whorl position on a similar number of cone-bearing trees. These were selected at random by a single observer using binoculars. An accuracy check, after felling several good cone-bearing trees showed that the observer counted 97 percent of the actual number of cones.

The percentage of the trees bearing cones was inversely proportional to the residual basal area in the range of stand densities observed. Ninety-six percent of the trees were bearing cones in the heaviest thinning, but only 19 percent had cones in the lightest thinning (table 1). Figure 1, using the estimated basal area in late July 1959 at the approximate time of flower bud differentiation for the 1961 cone crop, suggests that all trees would probably be bearing cones at lower residual densities.

The greatest number of trees per acre bearing cones occurred at a residual density of 115 square feet, but only two-thirds of all the trees in this level were fruiting. At the higher densities, the few trees with cones generally had small crown openings to the south or west. They also tended to be the larger trees in the stand (table 1). The average diameter of the cone-bearing trees gradually rose above the average stand diameter as the residual basal area increased.

The number of cones per tree and per acre was highest in the most heavily thinned compartments. There was considerable variation in the number of cones per tree within each stocking; apparently small differences in tree spacing can cause big differences in number of cones produced. The most cones occurred on the trees with the larger, better developed crowns, primarily those most released at the first thinning.

Cone location in the crown was only partly related to residual basal area. One-half to two-thirds of the cones were found in the middle one-third of the living crown at residual densities of 60 to 140 square feet. In the 160-square-foot density, only 9 percent of cones were observed in this zone. Few cones occurred in the lower one-third of the crown even at the lowest density. Number of living whorls 10 years after thinning ranged from 22 at 60 square feet to 17 at 160 square feet.



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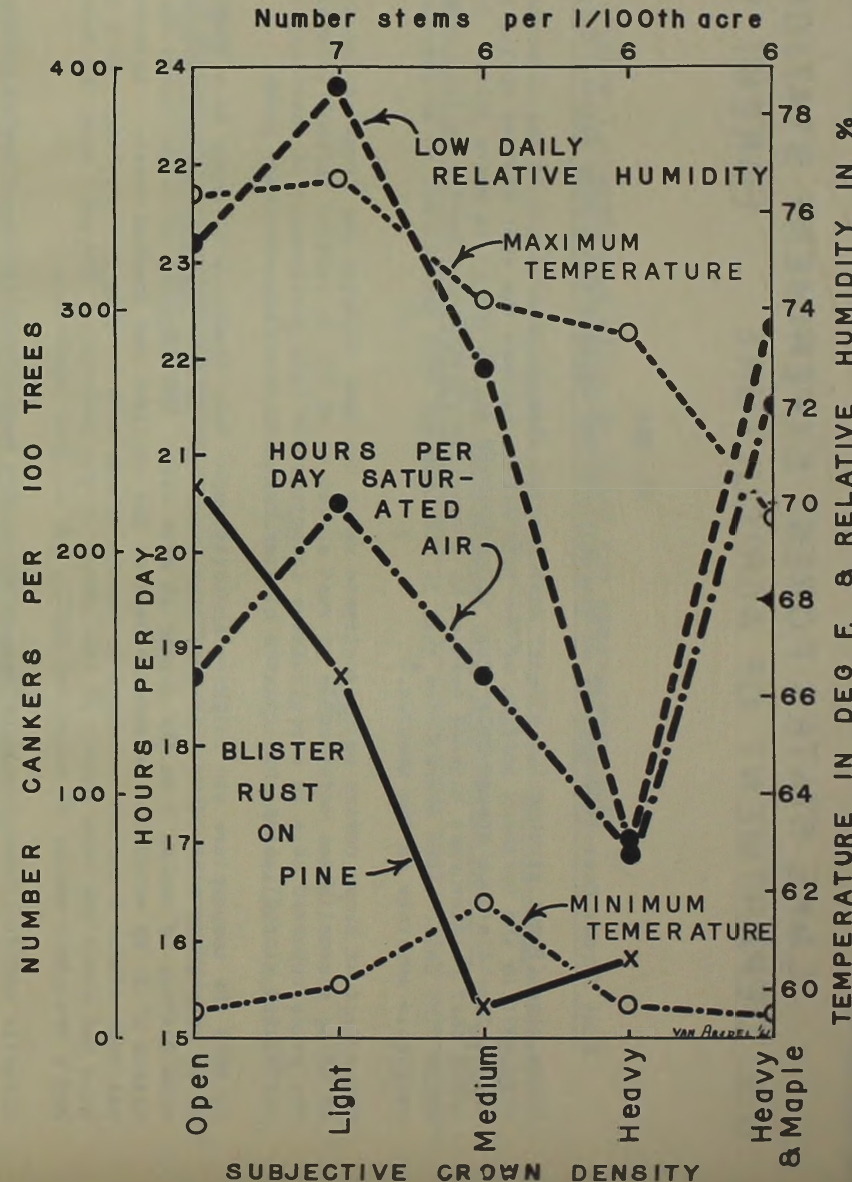

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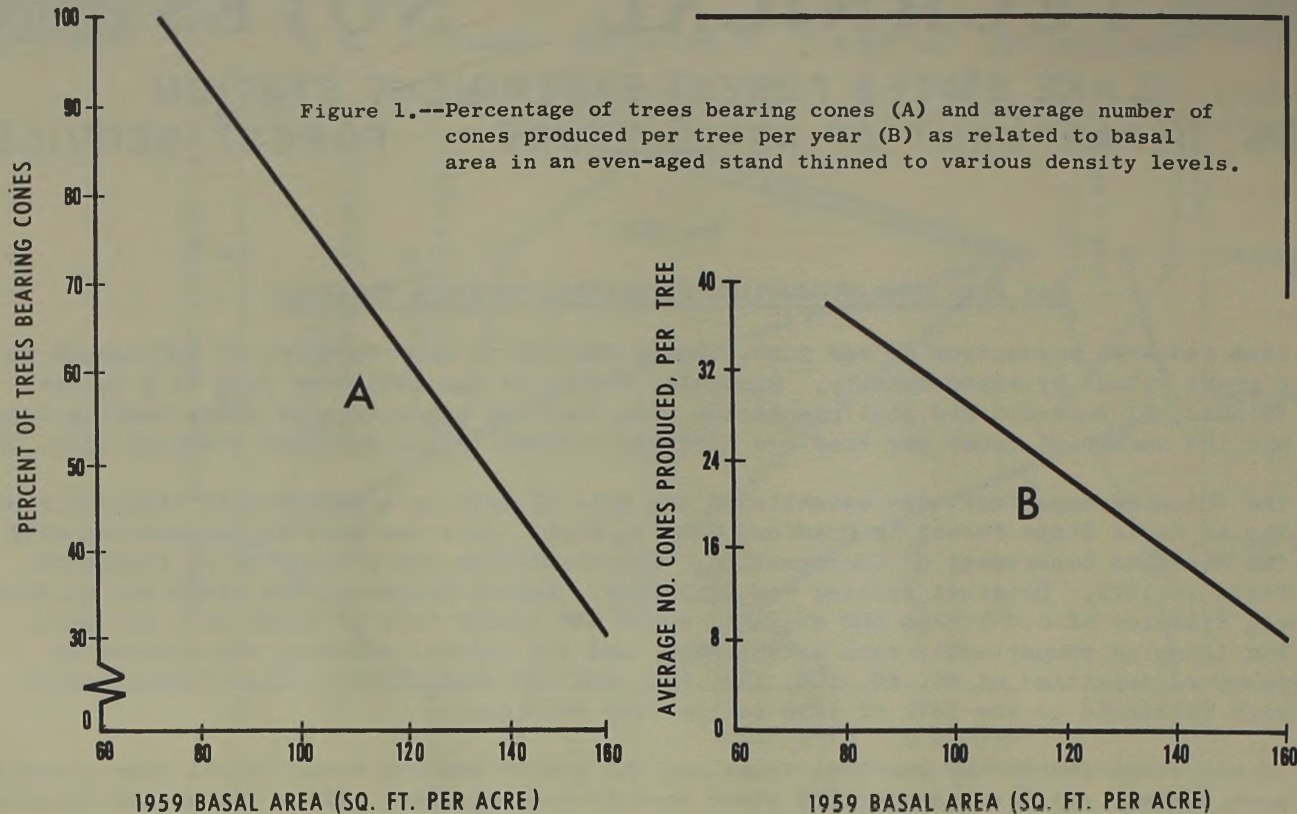

Figure 1.--Percentage of trees bearing cones (A) and average number of cones produced per tree per year (B) as related to basal area in an even-aged stand thinned to various density levels.

Table 1.--Stand characteristics related to red pine cone production after second thinning

Basal area per acre: Fall of 1956	Basal area per acre: 1959[1]	All trees: 1959[2] Trees per acre	All trees: 1959[2] Average spacing	All trees: Average d.b.h. 1961	Cone-bearing trees, 1961: Trees per acre	Cone-bearing trees, 1961: Proportion of total	Cone-bearing trees, 1961: Average d.b.h.	Cone-bearing trees, 1961: Cones per tree	Cone-bearing trees, 1961: Cones per acre
Sq. ft.	Sq. ft.	No.	Ft.	In.	No.	Percent	In.	No.	No.
67	85	255	13.1	8.4	245	96	8.4	38	9,310
79	95	340	11.3	7.5	269	79	7.7	34	9,146
98	115	440	10.0	7.3	308	70	7.6	14	4,312
118	132	487	9.5	7.3	219	45	8.0	15	3,285
138	154	540	9.0	7.4	189	35	8.2	14	2,646
161	174	900	7.0	6.1	171	19	7.5	2	342

1/ Estimated basal area in late July at approximate time of flower bud differentiation for 1961 crop. Includes most of 1959 growing season.

2/ The trees per acre and average spacing in 1956 and 1959 were the same as there was no mortality.

Heavy thinning is thus necessary to stimulate cone production in red pine, as the number of cones produced is closely related to residual basal area of the stand at the time of flower bud differentiation. Maximum yield per acre should occur at a residual density of about 80 square feet per acre. Maximum yield per tree, however, should be greater at lower residual densities than those observed in this study. In preharvest release to obtain natural regeneration or in roguing out seed production areas, residual densities should be maintained below 80 square feet to obtain a high-level and more uniform production of cones.

October 1962 R. M. Godman, Research Forester

TECHNICAL NOTES

LAKE STATES FOREST EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE · · FOREST SERVICE

No. 629

A 5-Year Progress Report in a Growing Stock Density Experiment in 60-Year-Old Red Pine

The relationship of basal area and cubic-foot-volume growth to stand density is being studied in several long-term experiments in Minnesota. With each succeeding measurement, the need for information at still wider ranges of stand densities becomes apparent. Prior to 1956 the widest range of basal area densities established on these experiments was 60 to 140 square feet per acre.

In 1956 a thinning experiment was begun in a red pine stand where the lowest density was 30 square feet of basal area per acre and the highest density of thinned plots was 150 square feet. Unthinned control plots were also established. This is a brief report on the first measurement period. The results show substantial agreement with three older red pine experiments[1/] for the common range of densities and add information at higher and lower densities.

The study, installed cooperatively by the Minnesota and Ontario Paper Company and the Lake States Forest Experiment Station, is located about 25 miles southwest of International Falls, near the northern border of Minnesota. The red pine averaged 58 years in 1956. Site index is about 55 at age 50, which is slightly better than medium for Minnesota. Before thinning, the stand contained some white pine, aspen, and white spruce. No thinning or other cultural treatment had been done in the stand prior to installation of the experiment.

The treatments consisted of thinning the stand to densities of 30, 60, 90, 120, and 150 square feet of basal area per acre. Unthinned treatments were also established with average basal areas of 175 square feet per acre. Measurements were made on 1/7-acre plots; each plot and its surrounding buffer zone together are 1 acre or more in size. Two replications were installed at age 58, the third at age 59. At age 63 the compartments were remeasured, and all three replications were thinned back to the assigned basal areas. The growth responses reported here are based on observations taken after 5 years on two replications and 4 years on the third.

The curves in figure 1 show gross and net periodic annual increment for basal area and for cubic-foot volume. The gross growth curves extend to 175 square feet of basal area, the highest density of the unthinned plots. Net growth curves extend to 150 square feet of basal area, the range of data to which they were fitted.

Tabulated below are the equations for predicting periodic gross and net annual increment in basal area and in cubic-foot volume from stand density in basal area. R^2 measures the proportion of the total variability around the grand mean that is accounted for by the prediction equation (all growth is per acre per year).

1/ Buckman, Robert E. Three growing stock density experiments in Minnesota red pine--a progress report. U. S. Forest Serv., Lake States Forest Experiment Station. Sta. Paper 99, 10 pp., illus. 1962.

	Increment equations	R^2	BA range of application
Gross basal area	$= 0.19 + .0341BA - .0000964BA^2$	0.80	30 - 175
Net basal area	$= .18 + .0351BA - .0001256BA^2$	.53	30 - 150
Gross cubic feet	$= 2.4 + 1.311BA - .00306BA^2$	.91	30 - 175
Net cubic feet	$= 10.4 + 1.257BA - .00392BA^2$	.66	70[1/] - 150

1/ Use gross figures for BA from 30 to 70.

The gross basal area growth curve rises to a maximum of 3.2 square feet per acre per year at a basal area of 175 feet. The gross cubic-foot growth curve continues to rise across the entire range of densities for which information is available.

Net basal area growth attains a maximum of 2.6 square feet per acre per year at 140 square feet of basal area, whereas net cubic-foot volume growth continues to rise beyond 150 square feet, the highest density from which the curve was derived. Stand densities 20 to 30 feet lower than the maxima given above make very little practical difference in growth rates. In terms of net cordwood growth (on the basis of 100 cubic feet per cord), the 30-, 60-, 90-, 120-, and 150-square-foot densities produced, respectively, .45, .72, .92, 1.05, and 1.11 cords per acre per year.

The minor quantities of aspen and white pine remaining in the high density and unthinned compartments suffered a disproportionately heavy mortality--the white pine because of blister rust (*Cronartium ribicola*), the aspen because of advancing age. These species were left as "filler growing stock" and were to be removed as soon as sufficient red pine basal area was present for the assigned density.

For the three unthinned plots the average net increment in basal area was 1.4 square feet per acre per year; net cubic-foot-volume increment was 92 cubic feet per acre per year. This is much lower than the growth of lightly thinned plots (those with a high residual density).

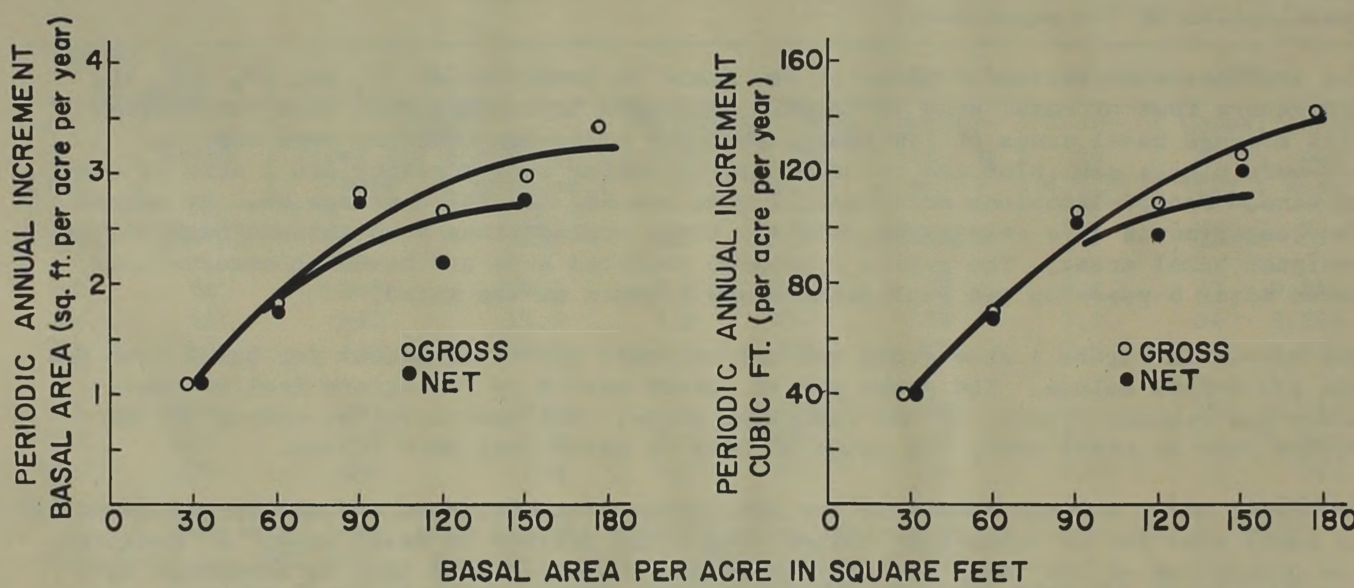

Figure 1.--Gross and net periodic annual increment curves for basal area (left) and cubic-foot volume (right) in relation to stand density in basal area. Each dot represents the average of three replications. Gross growth was calculated for all plots, net growth for thinned plots only.

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Lake States Forest Experiment Station

John Hubbard, Industrial Forester
Minnesota and Ontario Paper Company

October 1962